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HUMAN FACTORS STUDY OF ABILITY TO ESCAPE FROM A DITCHED CORMORANT HELICOPTER

by

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RÉSUMÉ

Le Canada prendra prochainement livraison de l'hélicoptère CH149 Cormorant afin de remplacer le CH113 Labrador vieillissant. Du point de vue des facteurs humains, les techniques et les voies d'évacuation sous l'eau seront passablement différentes de celles du Labrador, en raison de quatre modifications de conception fondamentales. Ces modifications comprennent le remplacement du sac à dos compact par un paquetage personnel de survie (PPS); les sièges à absorption d'énergie (amortisseurs); la forme, la dimension et le sens de fonctionnement des mécanismes d'éjection à tous les postes de membre d'équipage; et les harnais de sécurité à cinq points d'attache plutôt que quatre. On a demandé à la firme Survival Systems Training Ltd de mener une étude de facteurs humains sur la facilité ou la difficulté d'évacuer un hélicoptère Cormorant après un amerrissage d'urgence de même que sur l'interface de l'équipement de survie actuel avec le nouvel hélicoptère. Grâce aux résultats de cette étude, les Forces canadiennes pourront s'assurer qu'avant la livraison du premier hélicoptère le personnel navigant aura reçu une formation adéquate sur les meilleures techniques d'évacuation et de survie d'un Cormorant après un amerrissage d'urgence.

Mots clés : Cormorant; amerrissage d'urgence; évacuation sous l'eau; survie; sortie

SOMMAIRE NARRATIF

À la suite d'un amerrissage d'urgence, il est fréquent qu'un hélicoptère se renverse et coule rapidement. Afin de survivre, l'équipage et les passagers doivent faire une évacuation sous l'eau, alors qu'ils sont parfois blessés, terrifiés et désorientés.

Le présent document résume la facilité ou la difficulté d'une évacuation sous l'eau pour les pilotes, les mécaniciens de bord et les techniciens en recherche et sauvetage volant à bord du nouvel hélicoptère Cormorant à la suite des essais effectués par la firme Survival Systems Training Ltd, en janvier 2001. Le rapport présente également des recommandations relatives à d'autres travaux sur les facteurs humains visant à améliorer les possibilités de survie d'un équipage victime d'un amerrissage forcé à bord d'un Cormorant.

On a enseigné à dix volontaires comment évacuer de façon efficace le système de formation d'évacuation par modules (METS™) configuré pour le Labrador en portant tout l'équipement réglementaire (gilet de sauvetage, combinaison de survie, casque, gants, bottes, système respiratoire d'urgence). Le METS™ a ensuite été configuré pour le Cormorant et les éléments spécifiques suivants ont été évalués :

a) le siège amortisseur;
b) les portes droite et gauche des pilotes;
c) les issues des techniciens en recherche et sauvetage;
d) le paquetage personnel de survie (PPS).

Les volontaires ont réussi 149 évacuations sous l'eau. Le rapport présente plusieurs recommandations visant à réduire la fréquence de certains problèmes d'évacuation et à accroître la confiance des membres d'équipage dans leur capacité à évacuer efficacement un hélicoptère Cormorant après un amerrissage forcé. Dans le cas des membres d'équipage qui n'occupent pas un siège de pilote, il faudra leur enseigner des techniques spéciales pendant la formation à l'immersion afin qu'ils puissent localiser les leviers d'éjection et pousser le hublot à l'extérieur. Tout le personnel tenu de porter un PPS doit apprendre l'importance de le porter très serré (malgré l'inconfort) afin de réduire le risque que le PPS nuise aux procédures d'évacuation. Finalement, en raison des problèmes d'accrochage éprouvés au R.-U., on devrait s'efforcer de modifier le siège afin qu'on puisse utiliser le sac à dos compact plutôt que le PPS.

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INTRODUCTION

When a helicopter ditches, it commonly inverts and sinks rapidly (Reference 2, 3, 4, 5, 12, 13, 15, 17, 18).

The crew and passengers must make an underwater escape in order to survive. The sequence of events is generally as follows:

1. At water entry, aircrew and passenger anxiety. There is the loud explosion when the engine nozzles, which run at 600°C, are suddenly cooled as they hit the water. This can terrify the pilots and crew and result in "paralyzing anxiety".

2. Equally terrifying, is the sudden in-rushing water. One pilot described this like being hit in the chest by a fire hose.

3. In the process of hitting the water, in at least 50 percent of cases, the helicopter will rapidly sink and rotate. At a time of panic, disorientation and in-rushing water it is necessary to take a good breath before the submersion. Two factors make this difficult: (a) There is often very little warning of the ditching. (b) If the accident occurs in cold water (i.e., water below 15°C) it may be very difficult to control breathing (Reference 16).

4. Broadsmith (Reference 9) has modeled various helicopters and concluded that a helicopter may rotate several times before settling on the bottom or stabilizing out. The survivor, under such circumstances, will be disoriented due to false cues signaled by the organs of balance in the inner ear, loss of gravitational references and darkness or, paradoxically, by bright surface sunlight reflecting off the bubbles in the in-rushing water.

5. The victim must release him or herself from the seat harness and, by a process of swimming and dragging, move to, and make an escape through, a door, window, or hatch. This is more difficult for those seated at some distance from an exit. An exit may no longer resemble, in terms of either shape or function, its pre-accident condition. The escape is also made more difficult by: the restrictions of a highly buoyant survival suit; panicking survivors; corpses; personal equipment that has been hurled around the cabin; and seats and consoles displaced during the impact. Finally, the helicopter is primarily designed for emergency egress on land rather than underwater.

6. The victim, possibly injured, certainly terrified, disoriented, and at the limit of breath-holding, is capable of only a few simple actions to save his or her life. At this stage, a poorly designed, complex and tortuous escape route, or a confusing jettison mechanism will easily defeat him / her.

7. Adding to the problems, Allen et al (Reference 1) have demonstrated that underwater, even in the best conditions, humans cannot see further than 3.1 meters.

8. Because the majority of life rafts are stowed inboard, in all this confusion, the survivor has to decide whether to use up precious air by holding his/her breath to locate, release and jettison the life raft, or make as rapid escape as possible without it (Reference 8).

9. Once at an escape exit the jettison mechanism must be found and operated. Brooks and Bohemier (Reference 6, 7) observed great difficulty locating, finding and operating escape mechanisms underwater under the best of conditions. The choices open to a potentially

disoriented victim vary greatly in terms of: lever position; direction of operation; whether the lever matched the task; and whether the door, window, or hatch jettisoned in or out. Brooks and Bohemier (Reference 7) examined 35 types of marine helicopter and noted 23 different types of jettison mechanisms. They concluded that little thought had been put into the design of the helicopter for underwater escape; manufacturers had simply taken the principle of emergency ground egress from their land-based design and fitted it directly into the marine helicopter.

10. Even if the survivor has made a safe exit from the fuselage, it is still necessary to breath-hold until reaching the surface. As the helicopter sinks, it is not uncommon to have to make an escape in 5-10 metres of water. Due to Boyle's Law, below about 5 metres, the buoyancy in the survival suit or the lifejacket will assist the person safely to the surface, but it will still be necessary to swim. This requires hard work and significantly shortens breath-hold time.

If each person is not adequately trained to make an underwater escape, then he / she may perish during any one of the above sequence of events. One of the biggest hurdles to escape for even the uninjured, well-prepared person is the location of the emergency jettison levers and jettison of the escape door / window / hatch (Reference 6, 7).

All Labrador crew members must attend a helicopter underwater escape training course at Survival Systems Training Limited. Here they are taught to make a successful inverted underwater escape from the Modular Egress Training System (METS™). The initial escapes are conducted in daylight without doors and windows on the machine. As the course progresses, so does the complexity of the escapes. The final series of escapes are conducted in darkness. Wearing full equipment (immersion suit, boots, gloves, life jacket, helmet, backpack, Emergency Breathing System (EBS)), each student must demonstrate that he or she can successfully conduct cross cabin escapes. Refresher training is conducted every five years.

Canada has recently purchased the Cormorant helicopter to replace the aging Labrador. From the human factors aspect, underwater escape routes and techniques will be significantly different because of four fundamental changes in design.

(a) Replacement of the slimline backpack (which contains the life raft and survival equipment with a personal survival pack (PSP)). This fits in the seat pan and is attached to the crew member's buttocks by tape and snap connectors on the life jacket when the crew member is strapped in the seat. On egress, the PSP pulls out of the seat and theoretically remains secured to the buttocks of the crewmember throughout the escape process.

(b) An energy absorbing seat. This strokes vertically on impact approximately 10 inches towards the deck. Thus the jettison levers and whole ergonomics of the surrounding cabin has to be assessed physically and visually underwater from an entirely different perspective.

(c) The shape, size and direction of operation of the jettison mechanism for the Pilot and Co-pilot are unique in that it rotates inboard through a 90° arc. The mechanism for the Search and Rescue Technicians is entirely different from those in the Labrador in position and method of operation.

(d) A 5 versus 4-point harness.

Taking these factors into consideration, Survival Systems Training Ltd. was asked to conduct a human factors study of the ease or difficulty of escaping from a ditched Cormorant helicopter.

Previous work has been conducted by Cummin et al (1992) and Cummin (1993) at the RAF Institute of Aviation Medicine. This was specifically to examine escape from the mission booth of the Merlin helicopter (EH-101) of which the Cormorant is a version.

The conclusions from the first study were related to the potential snagging problems of the PSP and the requirements for the use of an EBS (Reference 10).

"...because the results were compromised by the training effect of previous runs and the impossibility of simulating the chaotic consequences of a real accident. Nevertheless, in the circumstances of the experiment, subjects were able to escape from the primary exit with their PSPs quickly enough for their immediate survival even when visibility was limited or absent. Egress from the secondary exit via the primary exit took too long for the additional delays expected from opening or trying to open each exit suggest that a short term air supply needs to be provided to give aircrew a reasonable chance of escape via this route. Snagging caused by the PSP was a repeated potentially serious problem; there was some suggestion that this may be less likely when the PSP is fitted tightly. Harness release difficulties were, at least in part, caused by unfamiliarity with the mechanism; experienced aircrew could be expected to perform better. The beta-lights did not help the subjects find the guide bar. Better illumination of the guide bar and exits should enable the victim of a real accident to orientate himself and make his escape more certain but in simulations subjects learn how to make their escape even in the absence of such aids."

The conclusions from the second experiment basically reconfirmed the effect of the Personal Survival Pack (Reference 11).

"Although there was only one report of the survival pack snagging, all but one subject (PR) took longer to escape with the PSP suggesting that the PSP causes other difficulties. One such problem is the delay that the PSP may cause when the subject leaves the seat – one subject did mention the tugging of the PSP at this stage. Another possibility is that underwater the PSP is rather unwieldy and buoyant and this may affect the ability of the subjects to manoeuvre and propel themselves through the water.

The incidence of snagging was lower than that found for escapes from the middle seat. Presumably the escape route from the port seat is not the snagging risk that it might appear. Certainly the route is considerably shorter than either of the routes used in the middle seat escape trials and this may have limited the opportunity for snagging. As far as passage through the exit is concerned, another factor decreasing the likelihood of snagging may have been that the 5 subjects who followed subject CM saw his difficulties on the video monitor while waiting their turn and decided that they would pass through the aperture either face up or on their sides, a strategy which appeared to work. The problem when passing through an aperture underwater is that the subject tends to float upwards and strike the uppermost edge of the exit. As a result, if the subject is face down, the PSP tends to snag on the edge and, if it is at all loose, it may even tend to float up on the inside of the aperture whiles the subject floats up on the outside. In such a position the subject cannot easily see the problem and by then his only solution is to free himself by placing his hands rather awkwardly behind himself and forcing himself and the PSP away. In contrast, when the subject is face up buoyancy tends to prevent the PSP snagging on

the lower edge and the arms are in the right position to counter any excessive upward movement. It might be worth considering these points during underwater escape training.

From the point of view of minimizing snagging, the design of the PSP may not be optimal. For example, the snagging problem that can occur when passing through an exit might be lessened if the offending edge of the PSP did not jut out so abruptly – a curved or sloped edge could well be better. A related problem is that aircrew can be so anxious about the possibility of snagging that they fail to connect themselves to the PSP. Aircrew might have more faith in a well-designed back mounted survival pack. While there is some evidence to justify this view, whether this approach would be a real improvement or introduce problems of its own is unclear..."

Problems related to with the UK type of PSP either with snagging or refusal to connect up to the PSP to some degree have been borne out by accident data and anecdotal evidence. Hayward (1999) reported 4 cases of problems (Reference 14).

(a) *"...As the helicopter rolled through approximately 60 degrees the Pilot regained consciousness and had the presence of mind to take a short breath. The window was jettisoned and, following harness release, the Pilot commenced egress through the exit. Almost immediately the egress was prevented and, after a moment of panic, the Pilot reasoned that the Personal Survival Pack had ridden up his back and caught the window frame. After a minor struggle with the Pack it appeared to come free and the Pilot broke the surface as his lungs emptied (Prior to the introduction of breathing aids). The helicopter sank within three minutes..."*

(b) *"...Immediately following impact; which was extremely violent and noisy, the helicopter inverted, rapidly filled with water and was in total darkness. After all violent movement had ceased.....The left hand seat Pilot immediately operated his harness release, paused to insert his Short Term Air Supply (breathing device) in his mouth, and then successfully egressed through the open sliding portion of the window. The Pilot made no attempt to jettison the full window and always flew at night with the sliding portion open because he was not confident that the window would jettison post impact. As a consequence, he did not connect to his Personal Survival Pack because he knew that it would not fit through the sliding portion of the window. Although safe on the surface of the water the Pilot did not then have access to a life-raft and, as a result, survival was prejudiced. The rear seat crew member remembered little of the egress sequence and only became fully conscious on the sea surface with his life-preserver fully inflated. He did not normally connect to his Personal Survival Pack because he was not confident in his ability to egress safely through his primary exit when attached to the Pack. Like the left hand seat Pilot the crew member did not then have access to a life-raft. His survival was also prejudiced."*

(c) *"The right hand Pilot was confident in his egress ability and always connected himself to his Personal Survival Pack during flight. Immediately following harness release he attempted to open the sliding portion of the window (without making any attempt to jettison it) but failed to operate the opening mechanism. At this point the Pilot's initial breath hold failed and he had to use the Short Term Air Supply System. After two further attempts the window was successfully opened and egress was commenced. Again, there was no attempt to jettison the window. When half way through the open window the Personal Survival Pack prevented further headway and the Pilot needed to return into the Cockpit to operate the Pack release mechanism. A further egress attempt was then made; only to falter because he was still connected to the Personal Survival Pack by the connecting lanyard [for life raft inflation].*

Following a final return to the Cockpit, the Pilot successfully egressed through the open window and, after swimming a number of strokes, broke the surface as his breathing device empted..."

(d) *"For the Sea King Observers (Navigators) fitment of a representative exit and radar/sonar console [in the dunker for training] was considered to be a major improvement. Many had previously not connected to their Personal Survival Packs because of the perception that the Pack would hinder or prevent egress through the exit (17.5 in. x 23 in.). The representative and realistic reconfiguration of the simulator demonstrated that such a feeling was unfounded."*

METHOD

The objective was to examine the ease or difficulty of underwater escape of the Pilots, Flight Engineers and Search and Rescue Technicians flying in the new Cormorant compared to the old Labrador helicopter.

Prior to the trials, and with the approval of the Deputy Project Manager, Finance and Procurement, NDHQ, our engineer visited GKN Westlands and obtained the fuselage layout and drawings of seats, windows, doors, avionics panels, Personal Survival Pack (PSP), etc. These were then accurately copied in stainless steel and ABS plastic (both of which resist corrosion from chlorinated water). All the components were then configured to the Cormorant and pre-trialed for safety and functionality in the Survival Systems modular egress escape trainer [METS™] (Figure 1).

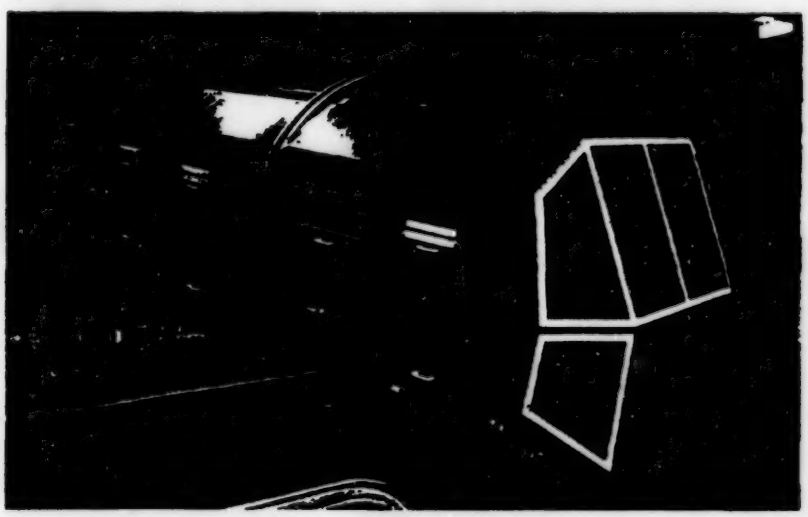


Figure 1: Survival Systems Ltd. Modular Egress Training Simulator (METS™)

Ten days before the human factors trial, ten subjects were trained to competently escape from the METS™ configured to the Labrador in full equipment (life jacket, survival suit, helmet, gloves, boots, emergency breathing system). Of the ten subjects, one each was a current Labrador Pilot, Flight Engineer or Search and Rescue Technician and all the remainder were qualified divers too. The subjects were then divided into three groups of three and one subject was held in reserve.

(a) 1 Labrador Pilot and 2 subjects trained to act as Labrador Pilots.

(b) 1 Labrador Flight Engineer and 2 subjects trained to act as Labrador Flight Engineers.

(c) 1 Labrador Search and Rescue Technician and 2 subjects trained to act as Labrador Search and Rescue Technicians.

The specific items that were evaluated were:

(a) The stroking seat (Figure 2A, 2B)

(b) The Pilot's doors, port and starboard (Figure 3A, 3B)

(c) The Search and Rescue Technician's exits (Figure 4A, 4B, 4C)

(d) The personal survival pack (Figure 5A, 5B)

Figure 2A: Stroking Seat (Front View)

Figure 2B: Stroking Seat (Rear View)

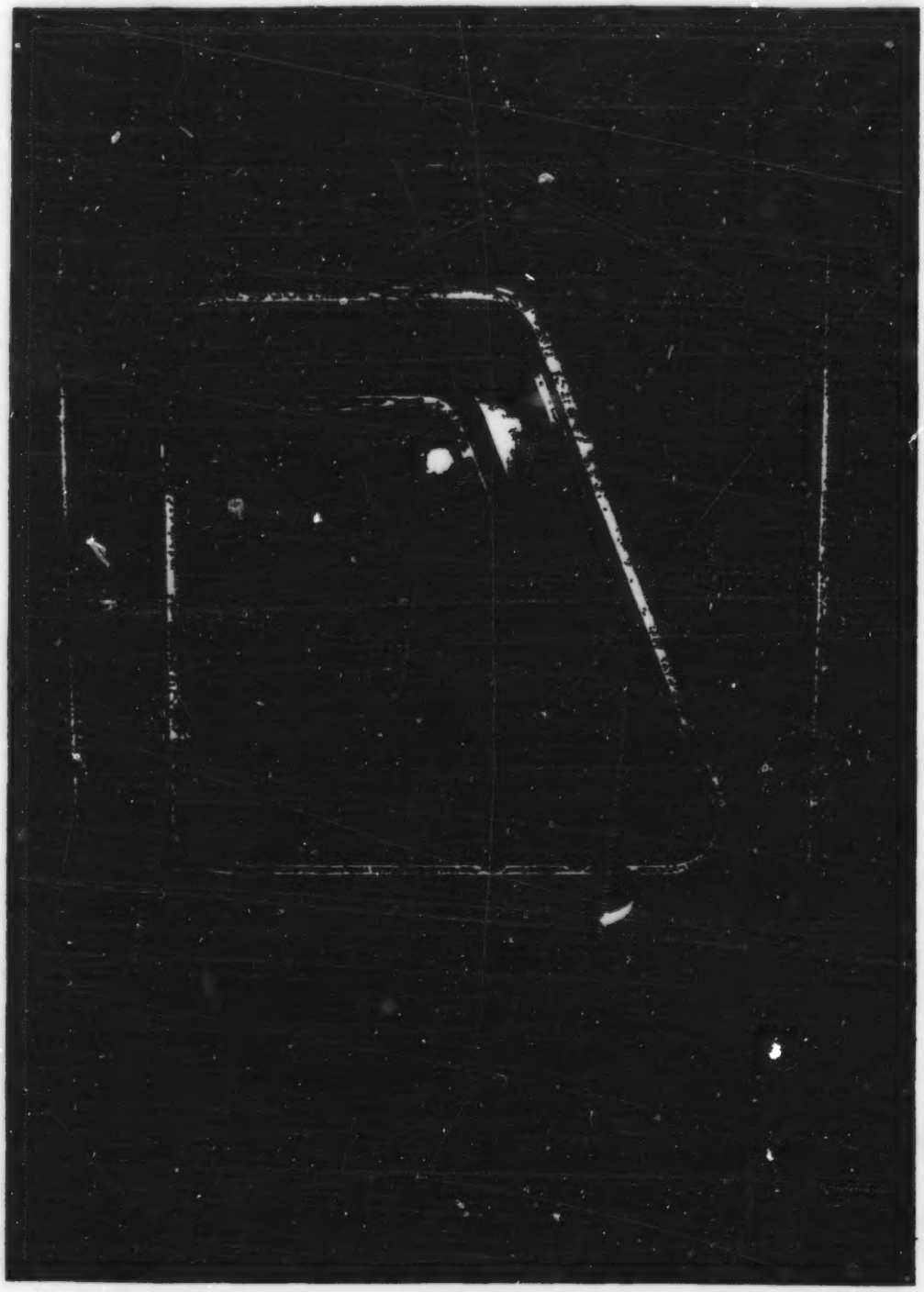


Figure 3A: Pilot Door (Port)

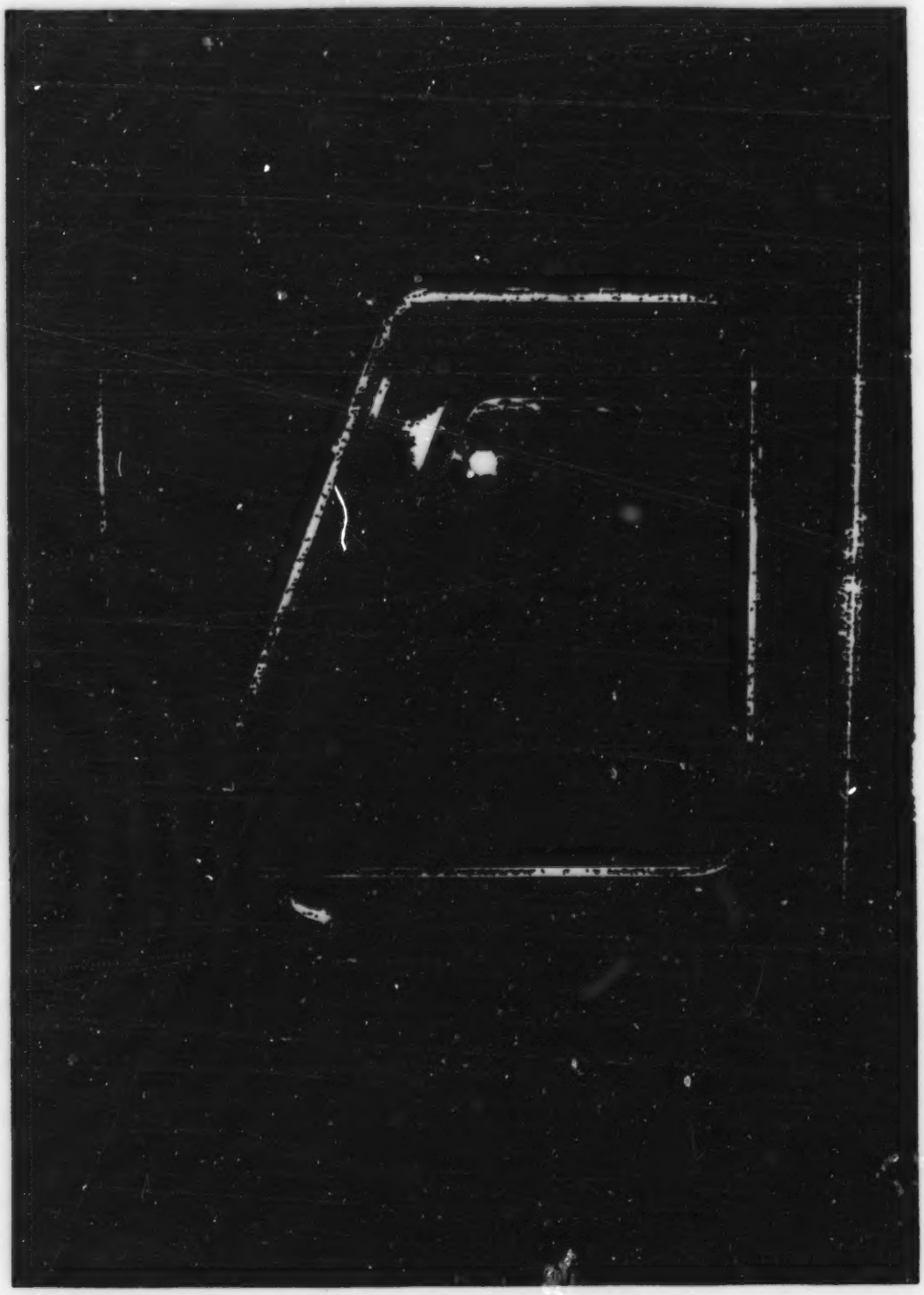


Figure 3B: Pilot Door (Starboard)

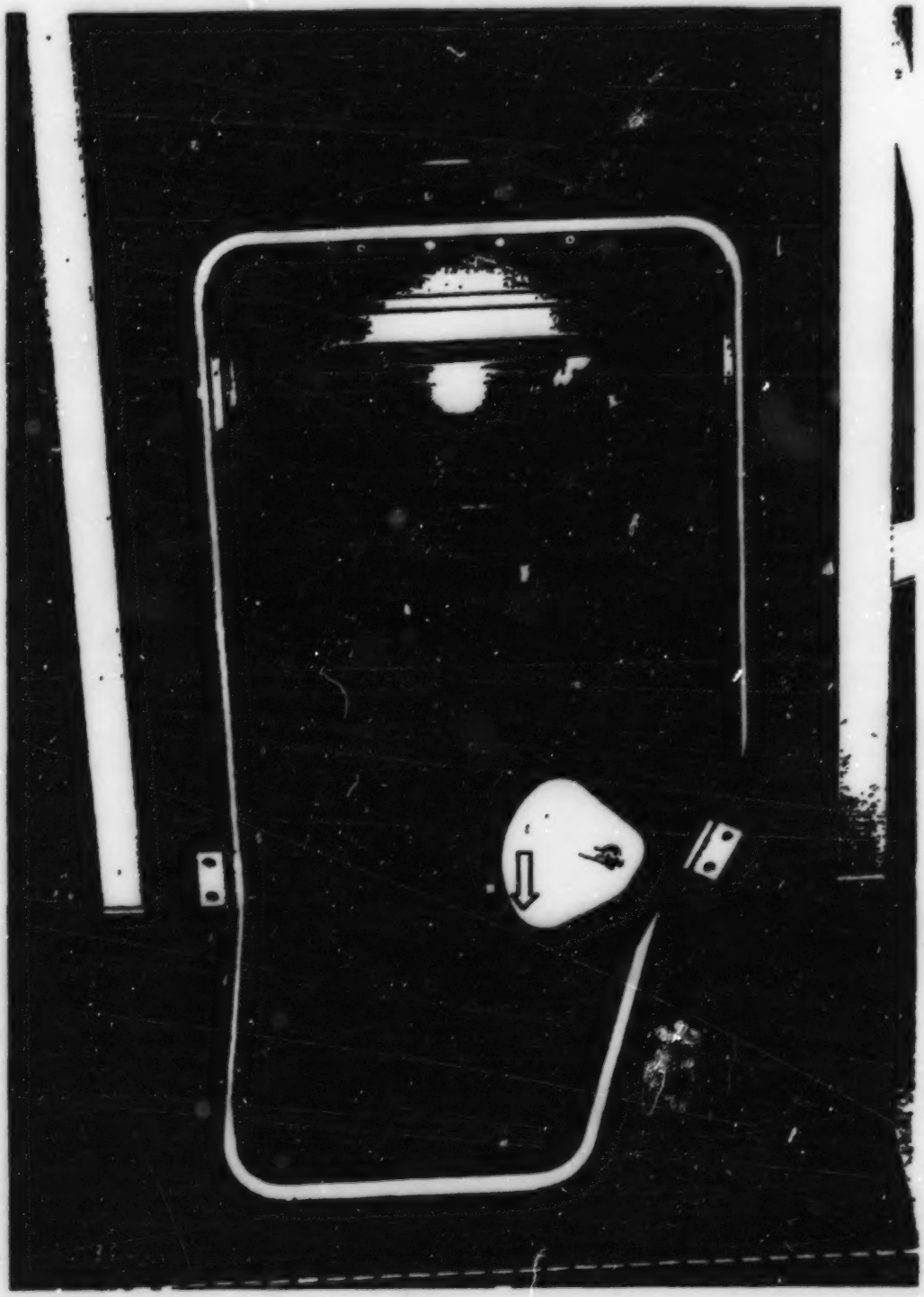


Figure 4A: Search and Rescue Exit (Rear Door)

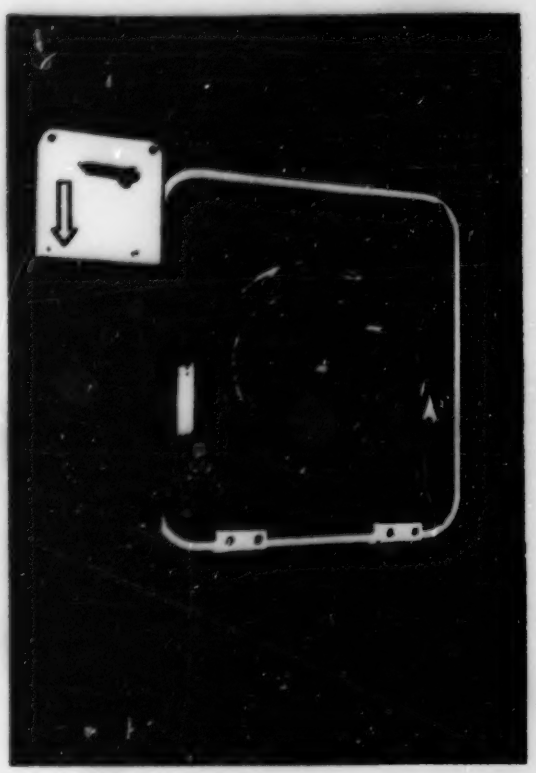


Figure 4B: Search and Rescue Exit (Port)

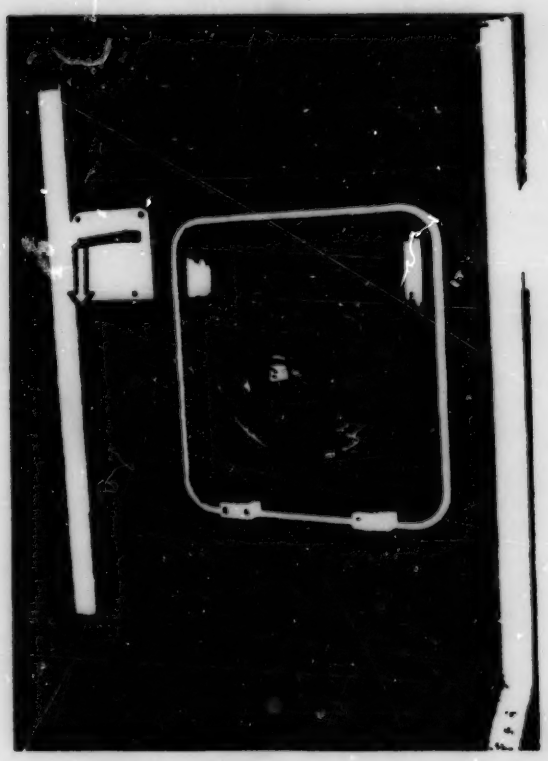


Figure 4C: Search and Rescue Exit (Starboard)

Figure 5A: Personal Survival Pack (Front View)

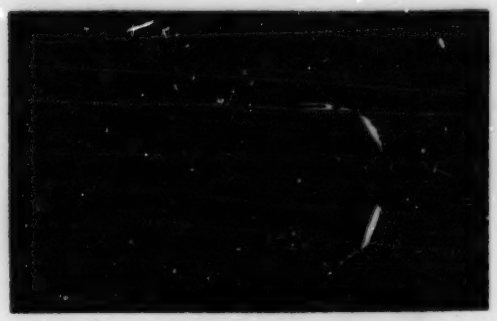


Figure 5B: Personal Survival Pack (Side View)

All of the above items (a - d) were fitted into the METS™ in as close an approximation to the manufacturer's drawings as possible (Figure 6). It was unclear in which direction the Search and Rescue Technicians seat would be facing on the port side. The engineering drawings indicated that it would likely be facing outboard and aft. So it was tested in the traditional position, facing forwards, then outboard and then aft. The Search and Rescue Technician's seat on the starboard side was tested in the forward and facing outboard positions. It was also unclear whether the Search & Rescue Technicians would ever sit on a personal survival pack or not in their stroking seat. But, in case they may have to do so, and also to gather more data on the performance of the personal survival pack, the majority of runs for them were done wearing a personal survival pack.

Of importance to note, in spite of all attempts made over a period of nine months, DCIEM were still not able to procure the precise 5-point harness for the seat or the correct Martin Baker connectors (male / female) to mate the life jacket to the personal survival pack. Therefore the standard military Apache helicopter quick release fitting was substituted on the 5-point harness and Fastex connectors were used on the seat pack.

On the first day of the trials each of the subjects was briefed on what to expect with the new exits, the new seat, stroked and unstroked, the 5-point harness and the anatomical layout of the fuselage. They were then allowed to walk around the fuselage, handle and operate each of the items.

The trails were divided into two phases:

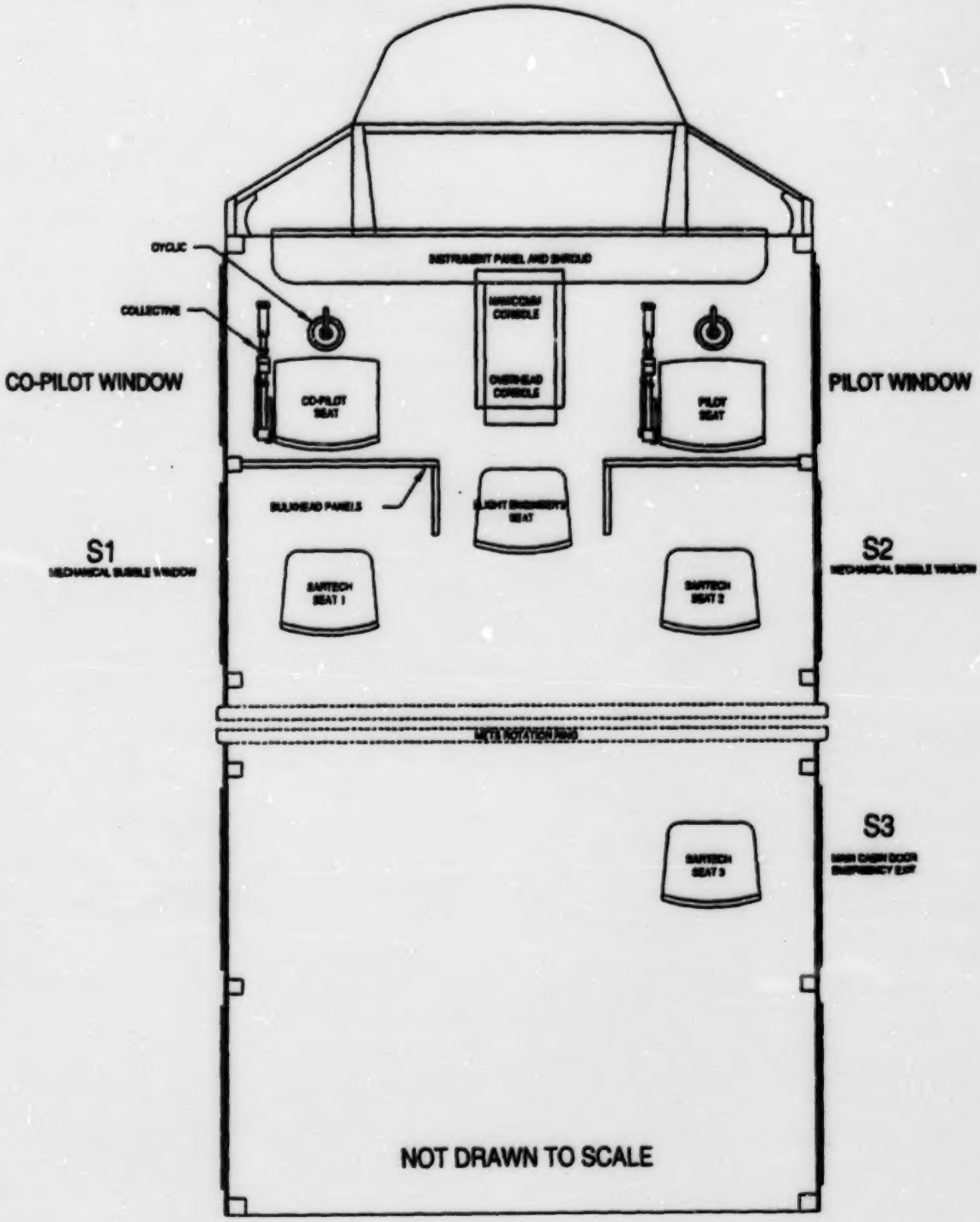
Phase I: Evaluation of escape from the Pilot and Flight Engineers positions together. (The Flight Engineers in the Labrador are always taught to immediately deploy their EBS and follow the Pilot out through the pilot window.)

Phase II: Evaluation of escape from each of the Search and Rescue Technicians positions.

For each of these phases all of the subjects wore their full equipment. The sequence of runs is listed in Annex A: Tables 1 – 4.

All the data was recorded on a time sheet (Annex A: Table 7, 8) and ease or difficulty on a questionnaire (Annex B, C, D).

Figure 6: Floor Plan For Evaluation In The METS™ (Not To Scale)



PHASE I: (Formal Trial: Day 1 – 2)

The Pilot and Flight Engineer, notwithstanding which seat the Pilot occupied, were always evaluated together. The Pilot jettisoned the window and always exited first, followed by the Flight Engineer exiting through the same window. The procedure on the command "ditching" was that they both assumed the brace position, then when underwater:

(a) For a direct escape:

- The Pilot sat upright in the seat.
- With the hand nearest to the door / window, located the jettison mechanism.
- Operated the mechanism and jettisoned the window.
- Transferred the hand grip nearest to the window to the window sill.
- Using the other hand, rotated the quick release fitting to release him / herself from the harness.
- Using the hand grip on the window sill, moved forward out of the seat to clear the harness and PSP from the seat bottom
- Then, by a mixture of swimming and leverage, made an escape through the now open window with PSP secured to the lifejacket.

If there were any problems with snagging, then he / she deployed the EBS regulator and commenced to breathe from it, cleared the snag and then escaped.

If there were further problems, then the instructor would free the subject either by disconnecting the PSP and / or activating the entire harness emergency release system [a specific safety feature on the METS™] and the instructor and safety diver would aid the subject through the hatch and back to the surface.

(b) For an indirect cross cabin escape:

- The Pilot sat upright, immediately deployed the EBS and commenced breathing from the regulator.
- With one hand nearest the direction of escape, physically identified a reference to which to swim and grasped it.
- With the other hand, he / she rotated the quick release fitting to release him/ herself from the harness, then moved forwards out of the seat to clear the PSP from the seat and the harness from the body.
- Then by a mixture of transferring the hand grip, pulling from one object to another and swimming, proceeded to the window on the opposite side of the cabin.
- When adjacent to the window, located the sill, grasped it and then escaped through the open window (the window was already jettisoned because it was assumed the Pilot in this seat would have already exited through it.)

If there were any problems with snagging then the instructor would free the subject either by disconnecting the PSP and / or activating the entire harness release system and the instructor and safety diver would aid the subject out of the hatch and back to the surface.

(c) The Flight Engineer for both a direct pilot egress and an indirect pilot egress:

- Sat upright in the seat, immediately deployed the EBS and commenced breathing from the regulator.
- Watched the progress of the Pilot locating and jettisoning the window.
- When satisfied, he / she was on the way through the exit, grasped the corner of the port or starboard seat with one hand (depending on which exit the Pilot was using i.e. if the port window was the exit of choice, the port seat was grasped).
- Then, using the other hand, released the seat harness. (Currently it is unclear whether the Flight Engineer will wear a 2, 3, 4 or 5-point harness. So for the trials a single lap strap and quick release fitting was used.)
- Then moved forward out of the seat to clear the harness (he / she is not attached to a PSP).
- Then by a mixture of transferring the hand grip from one object to another and swimming, proceeded to the window and egressed.
- The opposite window, i.e. the one not being used by the Pilot in the trial was always deliberately removed, so that if the Pilot had difficulty exiting, then the Flight Engineer either on his / her own accord or with assistance from the instructor and safety diver could exit through this window.

These procedures were conducted in daylight and darkness. For safety purposes, in the earlier trials the lights were turned off for 15 seconds and then turned on to dim lighting. As the subjects became very skilled and comfortable underwater, they noted that in the longer cross cabin escapes, the return to dim lighting gave them an artificial aid to locate the exit so they asked that the lights remain off for 30 seconds for the last three dark immersions (condition 10, 11 and 12 on Day 3). [Again it is unknown if any exit lighting will be fitted, and if only Beta lights are installed, they will provide little assistance for cross cabin exits.]

The Pilots tested the seat:

(i) Unstroked
(ii) Stroked

The Flight Engineer does not sit on a stroking seat.

(d) The Search and Rescue Technician, for a direct cross cabin escape:

- Sat upright and followed exactly the same procedure as that for the Pilot in condition (a).

(e) The Search and Rescue Technician, for an indirect cross cabin escape:

- Sat upright and followed exactly the same procedures as that for the Pilot in condition (b). Again, like the Pilot in the cross cabin condition, he / she egressed through an open exit because theoretically the window would have been already jettisoned by the Search and Rescue Technician sitting in the seat adjacent to that window.

The Search and Rescue Technicians tested the seat:

(i) Unstroked
(ii) Stroked

After the majority of the runs a questionnaire was administered both to the subjects and the instructors to inquire how easy or difficult it was to escape and the time was recorded for each person to escape. Where no questionnaire was administered, the instructor and subject were simply asked to add any comments to their previous experience.

The experimental protocol was approved by the Dalhousie University Human Ethics Committee and each subject signed the volunteer consent form.

PHASE II: (Additional Trial: Day 3)

After discussing the results of the trial from Day 1 and 2 with the three operational aircrew and noting our own observations, a mixture of additional runs were carried out on Day 3. These are listed in Annex A: Tables 5 – 6.

For the Pilots and Flight Engineers, these included escapes with no seat packs (runs 1, 2); vertical immersions (runs 3, 4); inversion to 90° (runs 5 - 7, 13 – 15); runs with the personal survival pack fitted loosely (runs 8, 9); and runs in extended darkness (runs 10 – 12).

For the Search and Rescue Technicians, these included turning the port side Search and Rescue Technician's seat forward (runs 24 – 30) and the starboard Search and Rescue Technician's seat outboard; and having both Technician's seats facing outboard (runs 31 – 36).

RESULTS

Nine males and one female for a total of ten subjects volunteered for the trial. The male height and weights ranged from 172.0 to 195.6 cms. and 64.0 to 113.6 kgs. The female height was 175.0 cms. and weight was 68.0 kgs.

All of the subjects were divers and three of the subjects were military aircrew from CFB Greenwood i.e. a Labrador Pilot, a Flight Engineer and a Search and Rescue Technician. The three Labrador aircrew received refresher training. This confirmed that they could successfully do cross cabin escapes in the METS™ configured to the Labrador helicopter. Of the remaining seven subjects, two were trained to represent a Pilot, two to represent a Flight Engineer and two to represent a Search and Rescue Technician. At the end of their training, they could escape as quickly and efficiently as the military aircrew. There was one extra subject trained in the event of a no-show and he filled in the Search and Research Technician position for one afternoon.

Escape Times:

These are listed in Annex A: Table 9, 10 and 11 for Pilots, Flight Engineers and Search and Rescue Technicians respectively. Ease or difficulty of escaping, as reported in the questionnaire, is listed in Annex B, C and D for Pilots, Flight Engineers and Search and Rescue Technicians respectively.

A. Pilot Escapes:

The time spent underwater by the Pilots conducting a direct escape in daylight ranged from 18.8 to 33.0 seconds. In darkness, the times ranged from 17.8 to 35.3 seconds. With the same

conditions, but the seat stroked, the times ranged from 17.7 to 29.0 seconds in daylight and 20.9 to 31.1 seconds in darkness.

For the cross cabin escapes, the times spent by the Pilots underwater ranged from 39.5 to 57.6 seconds in daylight and 43.9 to 63.0 seconds in darkness. With the same conditions, but the seat stroked, the times ranged from 42.4 to 55.5 seconds in daylight and 34.7 to 53.9 seconds in darkness.

With a loose PSP, the times spent underwater ranged from 19.9 to 96.3 seconds, the latter being the longest time recorded for a Pilot underwater doing a direct escape. The PSP snagged. As noted by Cummin, the PSP floated up on the inside of the sill of the window, while the subject floated up on the outside. Thus it was a considerable struggle to pull the PSP down from behind the back against the buoyancy to maneuver it through the aperture. With no seat pack, the time spent underwater by the Pilots ranged from 14.2 to 18.4 seconds for a direct escape in daylight and 27.4 to 42.4 seconds in a cross cabin escape.

The times for other configurations fell between this range of 14.2 to 96.3 seconds with the vertical escape being the most notable with a range of 47.8 to 58.4 seconds because of the effect of the PSP pushing the subjects up to the roof. It then required considerable effort to push oneself down against the buoyancy and work the PSP around the exit before escaping.

When questioned about the ease or difficulty of escape, the Pilots responses are depicted in Annex B: Table 1. They had no problems with locating and operating the jettison mechanism. The only problems were related to the PSP. In 39% of escapes, snagging problems were rated from extremely difficult to little difficulty (Annex B: Question 5). In 26% of escapes, the PSP buoyancy problems were rated from extreme difficulty to little difficulty (Annex B: Question 6). In 21% of escapes, passing through the exit was rated as extremely difficult to little difficulty (Annex B: Question 8). In 70% of all escapes, the Emergency Breathing System was used very successfully and in only two escapes were any difficulties reported (Question 10).

B. Flight Engineer Escapes:

The times spent underwater by the Flight Engineers was a reflection of the speed of Pilot escape. For direct Pilot escape, the Flight Engineer spent between 28.1 and 46.5 seconds. For cross cabin escapes, this increased to between 51.3 and 78.5 seconds. The Flight Engineers used the EBS on every occasion.

When questioned about the ease or difficulty of escape, the Flight Engineers responses are depicted in Annex C: Table 2. Generally speaking, they had no problems. This was principally due to the fact that, in every case, they used the Emergency Breathing System. Also, in every case, they reported no difficulty with it (Annex C: Question 10).

C. Search and Rescue Technician Escapes:

The times spent underwater by the Search and Rescue Technicians conducting a direct escape in daylight with the seat facing forward ranged from 15.5 to 26.0 seconds. In darkness, the times ranged from 16.2 to 26.8 seconds. With the same conditions, but the seat stroked, the times ranged from 18.0 to 24.7 seconds in daylight and 18.8 to 25.6 seconds in darkness.

For the aft facing seat, the times for direct escape ranged from 21.8 to 26.3 seconds with an unstroked seat and 19.3 to 22.2 seconds for a stroked seat.

For the cross cabin escapes, the times spent by the Search and Rescue technicians underwater ranged from 26.9 to 50.9 seconds in daylight and 27.8 to 47.1 seconds in darkness. With the same conditions, but the seat stroked, the times ranged from 31.2 to 43.7 seconds in daylight and 29.9 to 40.0 seconds in darkness.

The times for other configurations ranged between 20.5 to 69.4 seconds.

For a direct escape with a 90° inversion and seat facing outboard (i.e. helicopter floating on its side submerged or semi-submerged), the times ranged from 23.6 to 27.3 seconds for an unstroked seat and 20.5 to 24.8 seconds for a stroked seat. For a cross cabin escape with a 90° inversion, the times ranged from 47.6 to 69.4 seconds in an unstroked seat and 50.8 to 58.2 seconds with the seat stroked. For the condition of a vertical immersion in an unstroked seat the time was took 21.7 seconds in daylight and 39.7 seconds when the seat was stroked. When these two conditions were examined for a cross cabin escape, the times were 30.4 seconds for an unstroked seat and 21.2 to 49.8 seconds for a stroked seat.

Overall there was little difference between the escape times whether they were conducted from the port or starboard side.

When questioned about the ease or difficulty of escape, the Search and Research Technicians responses are depicted in Annex D. The problems were related to location and operation of the jettison mechanism and snagging and buoyancy of the PSP. Difficulty in locating the jettison mechanism was reported in 20% of escapes. These were rated from extremely difficult to little difficulty (Annex D: Question 2). Operation of the jettison mechanism was reported in 11% of escapes. These were rated from somewhat difficult to little difficulty (Annex D: Question 3).

The PSP caused snagging in 25% of escapes. This was rated from very difficult to little difficulty (Annex D: Question 5). Buoyancy from the PSP hindered escape in 32% of escapes. This was rated from very difficult to little difficulty (Annex D: Question 6). Passing through the escape exit with the PSP caused problems in 20% of escapes. This was rated as somewhat difficult to little difficulty (Annex D: Question 8). In 42% of immersions, the Emergency Breathing System was used and it functioned extremely well. Only 4 cases were reported of a little difficulty in operation (Annex D: Question 10).

DISCUSSION

The trials will be discussed in six parts. First the escape times; second, the location and operation of the jettison mechanism; third, the effects of the PSP on ability to escape; fourth, the requirements for training; fifth, the performance of the emergency breathing system; and sixth, options on the PSP.

All the observations must be premised by the following facts. All the subjects were volunteers, were divers, were very comfortable underwater, comfortable breathing from an EBS, and were highly trained in underwater escape. The pool water was 24°C; all the immersions were planned with adequate warning and there was no sudden re-arrangement of the anatomical structure of the fuselage on water impact, which could likely be expected in a ditched or fly-in helicopter accident. Furthermore, there was a marked training effect in their skill and ability to maneuver a snagged PSP underwater.

DCIEM were unable to obtain both the correct 5-point harness for each seat or the Martin Baker fasteners for mating the PSP to the life jacket. An AH-64 helicopter 5-point harness was substituted and 1" Fastex plastic connectors were used for the PSP. Both worked well and will not be commented on further.

A. Times for escape:

Generally speaking, with a very tight fitting seat pack, direct escapes by the Pilot will be achieved in between 18 and 35 seconds. The seat when stroked did little to affect these times. In the event of a cross cabin escape, the escape times will approximately double. A loose fitting pack, as demonstrated, had a profound effect on escape time. In one of the last runs (where the subject was highly skilled), the escape time for a direct exit was 96.3 seconds. The PSP got seriously snagged, the subject resorted to the use of his EBS and after considerable effort made a successful escape with no instructor assistance.

The Flight Engineer's escape time was always dependent on the ability and speed at which the Pilot could escape. The Flight Engineer can be expected to spend between 28 and 78 seconds underwater depending on the accident scenario, the skill of the Pilot preceding him / her and choice of exit. Hence the importance of continuing to train this crew member in the use of an emergency breathing system.

Direct escape times without a PSP were much quicker and were all achieved in under 18.5 seconds. It was not possible to apply any statistical significance to this number because there was only enough time to do two escapes in this condition.

B. The location and operation of the jettison mechanism:

For a maritime helicopter, little thought has been put into the design of any of the jettison levers, which may have to be operated in an inverted position underwater. The levers are not common throughout the aircraft, do not work in either direction, and, except for the rear door, the levers do not match the task (i.e. the lever does not depart the fuselage with the window). For those aft of the Pilot seats, a specific technique will have to be taught to locate the levers and jettison the windows. On the starboard side, they are positioned at the extremes of reach, and thus at a poor mechanical advantage to jettison the window underwater after operation, especially if the seat is stroked. None of the levers work from a central detent, but will operate in one direction only, adding the potential for reversal errors. To confuse matters even more, the lever on the port side is not a mirror image of the copy on the starboard side. Therefore, it is behind the left shoulder and not in the ideal position for location and jettison. The lever in the door is positioned behind the starboard seat and again is not in the ideal position for location and jettison.

More specifically, three different mechanisms are fitted in the Cormorant (Figure 3A, 3B, 4A, 4B, 4C). The pilot mechanism is quite unique among jettison mechanism. It is a flat lever with knob that rotates out from the fuselage to about 90°. It was easy to find and easy to operate. There was only one observation where the front of the life jacket got temporarily snagged on it during the escape. No one failed to locate and operate it.

The second mechanism fitted on each of the windows in the stern (S1 and S2) was a flat lever recessed into the skin of the fuselage. It only operated in one way by moving from 9:00 o'clock to 6:00 o'clock both on the port and on the starboard side. It was generally easy to operate, but not as easy to locate if the seat was stroked because of the much longer reach required.

Whether the seat was stroked or not, it was not easy to push the window out because the arm was at the point of full extension to reach the tip of the lever. This left the shoulder and arm at a poor mechanical advantage to exert force to push out the window. No one failed to locate and operate it. On the port side (S1), the lever was tested with the seat facing forwards, aft and outboard. This was done because it is unclear in which situation the Search and Rescue Technician may find him / herself facing on ditching. It was generally easy to operate, but location was not as easy with a stroked seat and not as easy with the seat facing forwards. In this condition, the lever is at the back of and behind the left shoulder. While in the straps, it needed considerable skill to wriggle around underwater to locate it. No one failed to locate and operate it from this seat in any position. A special technique will have to be taught in the dunker training to (a) locate the lever, and (b) push out the window.

The third mechanism (S3) is a flat lever fitted into the door that jettisons it. This lever rotates from 9:00 o'clock to 6:00 o'clock. It is situated in the lower quadrant of the door panel. It has to be reached by leaning back with the right shoulder and then by using the back of the right hand to follow the door panel down until it reaches the indentation in the door panel. Then, it is necessary to rotate the wrist in order to confirm location. The temptation is then to try to grip it in this position and push it down, but if this is done, as one subject discovered, the hand becomes trapped inside the recessed panel at the bottom of the stroke of the handle, thus the door does not jettison. It is therefore necessary to grasp it between the web of the thumb and index fingers and push it down to avoid this complication. This lever was not as easy to locate and operate. One subject (the highly trained Search And Rescue Technician) failed to locate it and then exited through an alternative S2 window. This demonstrates that special attention will have to be made in the dunker training to teach students to locate and operate this mechanism.

C. The effects of the seat pack:

The dummy seat pack exerted 17 lbs. of buoyancy and floated in exactly the same manner as the GQ parachute company manufactured PSP packed by DCIEM with life raft, flares and beacon and an empty CO_2 cylinder. With a full CO_2 cylinder and additional items such as mitts, it is estimated the PSP will exert about 16 lbs. of buoyancy. We conducted a total of 82 runs with the PSP cinched down tightly to the Pilots and Search and Rescue Technician's buttocks. Two runs were done with a loose PSP (Annex A: Table 5: Trials 8, 9) and two runs were done with no PSP (Annex A: Table 5: Trials 1, 2). Our results confirm both the anecdotal and practical evidence discussed in the introduction. The PSP has the potential for being problematical in the escape process.

For all of the cross cabin runs the subjects were instructed to immediately use their EBS on immersion. The breath holding times for cross cabin escapes as discussed above took approximately twice as long. Without the EBS, very few people on a breath-hold while wearing the PSP would have been able to make a cross cabin egress. Everyone resorted to this on each occasion and had no trouble breathing from it. Important to re-emphasize is that they were all very proficient using it from the previous Labrador familiarization course and because they were all trained divers.

The basic problem is that the seat pack is buoyant and once the subject is out of the seat, no matter how tight it was cinched down to the buttocks, it rode up over the iliac crest and positioned itself in between the mid-lumbar and mid-thoracic part of the spine (Figure 7). This led to a longer time spent underwater while the subject maneuvered the PSP around the cabin towards and out of the escape exit, while at the same time fighting the effect of buoyancy pushing the subject either to the floor or roof.

Figure 7: Test Subject Wearing Seat Pack.
This photograph illustrates two points. First the good anthropometric spread in subject height; second, the Search and Research Technician is indicating the position the PSP adopts once the person has released the seat harness underwater.

At the beginning of the trials, some subjects resorted to the EBS even for the direct escapes. As they got more skilled at escape and the sensation of the PSP riding up on their back, they were able to escape without the use of the EBS. This re-emphasized the point that intense and much more frequent training will be required for weaker students who are not divers and not comfortable inverted underwater.

In 39% of Pilot escapes and 25% of Search and Rescue Technician escapes, snagging was reported. In 26% of Pilot escapes and 32% of Search and Rescue Technician escapes, problems with PSP buoyancy were reported. In some cases escape was extremely difficult.

The PSP basically has the potential for snagging anything and anywhere along the escape path and particularly on the lip of the window as the final escape is made. It was even more noticeable when vertical rather than inverted immersions were conducted. Once the seat harness was released, the PSP pushed the person to the roof and then it was necessary to twist around at an odd angle and drag the PSP down and under the lip of the open window. A theoretically simple direct escape from the pilot window took the Pilot 96.3 seconds to achieve.

Not only was this the longest time spent by anyone underwater, but it occurred on his 15th run on the third day. So the delay cannot be blamed on lack of practice.

The aircrew commented that it would be very uncomfortable to fly with the PSP in a normal flight operation cinched down as tight as was worn. We do not disagree with this comment. To test the effects of a looser fitting PSP, two runs were done with the seat pack cinched down to a "comfortable" tightness. Under these conditions, the PSP swung around considerably more than in the tight condition. This added an additional snagging problem in that it was now possible to get snagged on the one-inch tapes themselves connecting the PSP to the life jacket (i.e. cyclic, collective, corners of the seat), rather than the PSP itself.

In spite of all of the snagging problems, noted by the subjects and the instructors alike, no subject failed to make a successful escape. This was because they learned to twist, turn and wriggle around, using their hands as necessary to maneuver the PSP along the escape path. They also used their EBS for some of the direct escapes and all of the cross cabin ones. This yet again re-emphasized the point that more frequent training is necessary to reach this level of skills, both in maneuvering the PSP and being comfortable breathing from the EBS.

D. Level of training:

It can be seen from all of the aforementioned observations that in the event of a ditching, the aircrew must be highly skilled at being able to maneuver the PSP through a potentially complicated escape, certainly if there is no warning, the accident is in cold water and there is serious cabin distortion and entrapment. For this scenario, the use of the EBS must be second nature. This must be the reason why the Royal Navy insists on dunker refresher training every two years. Current Canadian refresher training is done every five years. This is considered inadequate for those who are weaker students, non-divers and uncomfortable underwater. A member of the crew at the end of five years currency may not be able to make a successful escape and less so if it is at all complicated. The argument that the Pilot can jettison the PSP if all else fails may not be the case. In the event of a ditching and snagging, a person who has not had refresher training in the fourth or fifth year will have difficulty releasing one of the Martin Baker connectors and the maritime lanyard. The alternative to this is to, like some British aircrew are reported to do, simply not connect themselves to the PSP when strapping in the helicopter.. This means that if they ditch they will not have their beacon, life raft or survival aids at the surface. Training must be done at least every three years and should be reinforced with mandatory six monthly wet dingy drill in the Wing pool with a SWET chair and the PSP attached to their life jackets. No one should be allowed to fly the Cormorant over water without these qualifications.

None of the difficulties with the PSP are new. Our chief instructor taught at the Royal Navy Dunker in Yeovilton for 4½ years and noted precisely the same problem when their dunker was configured for aircrew of the Wessex, Lynx and Sea King. The solution was to mandate regular two year dunker training. If the aircrew went over this date, they were grounded and lost flying pay until requalified. It was also observed in both of Cummin's experiments at the R.A.F. Institute of Aviation Medicine in Farnborough, UK.

E. Performance of the Emergency Breathing System:

The EBS used was the Aqua Lung Helicopter Aircrew Breathing Device (HABD). This is known as the SRU-40P in the U.S. Navy. This is the current unit in service with Canadian Sea King

and Labrador crews. It is the unit that superceded the original Submersible Systems Inc. STASS unit. It performed immaculately. The reasons for this were:

(i) the level of skill the subjects had acquired,
(ii) the fact that they were all divers and therefore by natural selection, comfortable underwater, and
(iii) the fact that it is a very good, reliable piece of equipment.

F. Options on the PSP

The Canadian Air Force has traditionally flown with a slimline backpack to stow their life jacket and survival equipment. With acceptance of a British / Italian designed helicopter, they have had to accept a PSP versus a slimline backpack. It is unclear why the Royal Navy and Royal Airforce originally converted from a backpack to a PSP, but one theory is that it caused less wear and tear on the contents of the survival kit. This was because it was now stowed in the seat pan and only removed at routine seat maintenance and periodically for kit maintenance. Being worn on the back of the aircrew each flight, being carried around the crew room, being strapped in the helicopter on a daily basis subjected it to potential damage. However, substituting one potentially good solution has in fact created another human factors problem. The PSP has the potential to snag the crew on escape if they are not highly skilled in underwater escape and very comfortable breathing from an EBS. After investigating several ditchings, it is not surprising that the Royal Navy found that several aircrew did not physically connect up the Martin Baker connectors on their life jackets to the PSP. On the positive side, they did not drown, but on the negative side found themselves at the surface with no survival equipment or life raft.

In the very short term, the answer is first to increase the frequency of dunker training. In the intermediate term, the answer may be to re-examine the option of vacuum packing a small single seat life raft, mounting it on the thigh or calf, putting the beacon and other survival aids on the life jacket and abandoning the PSP as a storage container. Various countries now install the beacon directly on the life jacket, so this is not a difficult task if a slimline model is used. There is anecdotal evidence that some aircrew fly with a one man life raft in the flying suit. This idea was originally rejected in Canada because of the availability and superiority of placing it in the backpack. DCIEM might consider discussing this option with NDHQ and 1 – Canada Air Division.

In the long term, at the first refit, it is recommended that the work be done on the seat to re-accept a slimline backpack and the PSP can then be abandoned.

CONCLUSIONS

1. 149 underwater escapes were successfully completed by ten subjects. Three acted as Pilots, three as Flight Engineers and three as Search and Rescue Technicians. The additional subject was a back-up and he was used on one afternoon. One of each of these professional groups was a qualified Labrador Pilot, Flight Engineer or Search and Rescue Technician from 413 Training Squadron, Greenwood, Nova Scotia. A whole spectrum of seating positions and immersions (180°, 90° and vertical) were evaluated.

2. All subjects were pre-trained in the dunker configured to the Labrador. All were divers, comfortable underwater and very competent in the use of an EBS. Thus, they were highly skilled at underwater escape. The water temperature was 24°C.

3. Location and jettison of all three mechanisms was successfully achieved in all escapes bar one. There was no difficulty in locating and operating the jettison mechanism for the pilot windows, but there was a little difficulty in locating and operating the other two mechanisms in the stern. The Search and Rescue Technician completely failed to find the mechanisms in the starboard door on one of the immersions. The difficulties are caused basically because, first, each lever has been positioned at the extremes of reach, and thus provides a poor mechanical advantage to jettison the windows and, second, on the port side, if the Search and Rescue Technician faces forwards, it is behind the left shoulder. This problem can be overcome by regular, more frequent training.

4. It is not know whether the Search & Rescue Technicians will sit on a PSP or not. Nevertheless the seat was located in the precise position in the METS™ according to the engineering drawings. So the observations regarding the location of the jettison mechanism and jettisoning the windows remain the same.

5. In spite of the fact that the PSP was cinched down tight on to the buttocks in over 25% of runs, the subjects noted that it caused them at least a little difficulty in escape; in some cases, more difficulty. It required considerable skill to maneuver the PSP out of the seat and out of the window both directly and across cabin. It had the potential for snagging throughout the escape path. This is not new information. It has been already noted previously by Cummin in his research at the RAF Institute of Aviation Medicine and borne out by R.N. Boards of Inquiry.

6. It is doubtful that aircrew could tolerate the PSP cinched down on to the buttocks as tight as it was secured in this trial. Slacking off the PSP retaining straps to a comfortable level only increased the potential for snagging.

7. As has repeatedly been stated in this report, the subjects became very skilled at maneuvering the PSP directly out through the cabin windows or across the cabin. However it cannot be stated with any confidence that aircrew who are not divers, are not comfortable underwater or who currently conduct five yearly refresher training will be able to make a successful direct or cross cabin escape with the PSP fitted tight or slack on their buttocks, or even be skilled enough to locate the Martin Baker connectors to jettison the PSP and the barrel connector on the maritime lanyard.

8. The U.S. Divers Aqua Lung HAPD Emergency Breathing System functioned flawlessly throughout the trial. It was routinely and successfully used by every subject for every cross

cabin egress while using the PSP. It was also successfully used by the Flight Engineers for every single escape, and by several Pilots conducting direct escapes.

9. The seat harness and Martin Baker clips were not evaluated because DND could not obtain them in time for the trial.

10. For the procurement of the new helicopter to replace the Sea King, the specifications, at the minimum, should require all the jettison levers to be common throughout the helicopter, they should operate in such a manner to match the task, and they should operate in either direction. With the person fully strapped in the seat, they should be positioned within 25 cms. reach of the outstretched hand with the forearm resting on the thigh and the elbow touching the iliac crest. Finally the requirements to accommodate a slimline backpack and not a PSP should be clearly stated.

RECOMMENDATIONS

1. No aircrew should be allowed to fly in the Cormorant over water without current underwater escape training specific to helicopter type.

2. In order to become skilled at underwater escape, the behavior of the PSP and the requirements to become comfortable with the use of the EBS, refresher dunker training should be conducted every three years with the proviso that wet dinghy drill with the use of a SWET chair and PSP be conducted in the local Wing pool at six monthly intervals.

3. The training should emphasize the following key points:

   (a) For all crew that will wear a PSP, the methods to cope with the additional buoyancy, potential for snagging and techniques to unsnag.

   (b) For all crew not sitting in the pilot seat, the location and operation of the jettison mechanism and the technique to push the window out with the arm in full extension, and location of the jettison mechanism and jettison of the door.

   (c) The requirement for the use of the EBS at all times for the Flight Engineer and for any crew that are forced to do a cross cabin egress or who become snagged with the PSP.

4. As a result of the PSP snagging problem, which have been demonstrated both practically in the field and experimentally in the dunker, alternate solutions should be sought in the mid-term for the PSP. Consideration should be given to initially transferring the beacon to the life jacket and wearing a slimline vacuum-packed life raft on the thigh. In the long-term, the PSP should be replaced with a slimline backpack and necessary seat modification.

5. DCIEM must issue two modification leaflets:

   (a) To mate the Martin Baker connectors and the maritime lanyard to the PSP.
   (b) To mate the EBS to the life preserver / survival vest.

6. Due to the long lead time in procurement, the Canadian Forces Supply system must immediately demand enough Martin Baker connectors and barrel connectors to outfit the Cormorant helicopter squadrons.

7. This report should be urgently passed on to the Maritime Helicopter Procurement office in NDHQ and forwarded to the office responsible for training the first Cormorant crews.

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ANNEX A:

Table 1: Day 1 – Protocol For Testing Of Pilots And Flight Engineers

Pilots and Flight Engineers tested simultaneously.
3 - Pilots and 3 - Flight Engineer
Each has 1 practice trial followed by escape trials.

The Flight Engineer always follows the Pilot.

Pseat =	Pilot seat
Cpseat =	Co-pilot seat
Pwindow =	Pilot window
Cpwindow =	Co-pilot window

1	1	P1	FE1	Surface escape	normal	light	Pseat	Pwindow	
1	2	P2	FE2		normal	light	"	"	
1	3	P3	FE3		normal	light	"	"	
1	4	P1	FE1	Straight out	normal	light	Pseat	Pwindow	Question
1	5	P2	FE2		normal	light	"	"	"
1	6	P3	FE3		normal	light	"	"	"
1	7	P2	FE1	Cross and out	normal	light	Pseat	Cpwindow	"
1	8	P3	FE2		normal	light	"	"	"
1	9	P1	FE3		normal	light	"	"	"
1	10	P3	FE2	Straight out	[redacted]	light	Pseat	Pwindow	"
1	11	P1	FE3			light	"	"	"
1	12	P2	FE1			light	"	"	"
1	13	P1	FE2	Cross and out		light	Pseat	Cpwindow	"
1	14	P2	FE3			light	"	"	"
1	15	P3	FE1			light	"	"	"
1	16	P2	FE3	Straight out	normal	light	CPseat	CPwindow	Informal
1	17	P3	FE2		normal	light	"	"	"
1	18	P1	FE1		normal	light	"	"	"
1	19	P3	FE3	Straight out	[redacted]	light	CPseat	Pwindow	"
1	20	P1	FE2			light	"	"	"
1	21	P2	FE1			light	"	"	"

Table 2: Day 1 – Protocol For Testing Of Search And Rescue Technicians

3 - Search and Rescue Technicians
Each has 1 practice trial and 8 escape trials.

S1 =	Left seat position
S2 =	Right seat position
S3 =	Right aft seat position

1	22	Ser1		Surface escape	normal	light	S1	S1	
1	23	Ser2			normal	light	S1	S1	
1	24	Ser3			normal	light	S1	S1	
1	25	Ser1	Ser2	Straight out	normal	light	S1,S2	S1,S2	Question
1	26	Ser3			normal	light	S1	S1	"
1	27	Ser1	Ser2	Out the left side	normal	light	S1 , S2	S1	"
1	28	Ser2	Ser3		normal	light	S1 , S2	S1	"
1	29	Ser3	Ser1		normal	light	S1 , S2	S1	"
1	30	Ser2	Ser3	Out the right side	normal	light	S2 , S1	S2	Informal
1	31	Ser3	Ser1		normal	light	S2 , S1	S2	"
1	32	Ser1	Ser2		normal	light	S2 , S1	S2	"
1	33	Ser1	Ser2	Out the left side	[redacted]	light	S1 , S3	S1	Question
1	34	Ser2	Ser3			light	S1 , S3	S1	"
1	35	Ser3	Ser1			light	S1 , S3	S1	"
1	36	Ser2	Ser3	Out the right side		light	S2 , S3	S2	Informal
1	37	Ser3	Ser1			light	S2 , S3	S2	"
1	38	Ser1	Ser2			light	S2 , S3	S2	"

Table 3: Day 2 – Protocol For Testing Of Pilots And Flight Engineers

Pilots and Flight Engineers tested simultaneously.
3 - Pilots and 3 - Flight Engineers
Each has 1 practice trial.
The Flight Engineer always follows the Pilot.

Pseat =	Pilot seat
Cpseat =	Co-pilot seat
Pwindow =	Pilot window
Cpwindow =	Co-pilot window

2	1	P1	FE1	Surface escape	normal	dark	Pseat	Pwindow	
2	2	P2	FE2		normal	dark	"	"	
2	3	P3	FE3		normal	dark	"	"	
2	4	P1	FE1	Straight out	normal	dark	Pseat	Pwindow	Question
2	5	P2	FE2		normal	dark	"	"	"
2	6	P3	FE3		normal	dark	"	"	"
2	7	P2	FE1	Cross and out	normal	dark	Pseat	Cpwindow	"
2	8	P3	FE2		normal	dark	"	"	"
2	9	P1	FE3		normal	dark	"	"	"
2	10	P3	FE2	Straight out	[redacted]	dark	Pseat	Pwindow	"
2	11	P1	FE3			dark	"	"	"
2	12	P2	FE1			dark	"	"	"
2	13	P1	FE2	Cross and out		dark	Pseat	Cpwindow	"
2	14	P2	FE3			dark	"	"	"
2	15	P3	FE1			dark	"	"	"
2	16	P2	FE3	Straight out	normal	dark	Cpseat	Cpwindow	Informal
2	17	P3	FE2		normal	dark	"	"	"
2	18	P1	FE1		normal	dark	"	"	"
2	19	P3	FE3	Cross and out	[redacted]	dark	CPseat	Pwindow	"
2	20	P1	FE2			dark	"	"	"
2	21	P2	FE1			dark	"	"	"

Table 4: Day 2 – Protocol For Testing Of Search And Rescue Technicians

3 - Search and Rescue Technicians
Each has 1 practice trial and 8 escape trials.

S1 =	Left seat position
S2 =	Right seat position
S3 =	Right aft seat position

2	22	Sar1		Surface escape	normal	dark	S1	S1	
2	23	Sar2			normal	dark	S1	S1	
2	24	Sar3			normal	dark	S1	S1	
2	25	Sar1	Sar2	Straight out	normal	dark	S1,S2	S1,S2	Question
2	26	Sar3			normal	dark	S1	S1	"
2	27	Sar1	Sar2	Out the left side	normal	dark	S1 , S2	S1	"
2	28	Sar2	Sar3		normal	dark	S1 , S2	S1	"
2	29	Sar3	Sar1		normal	dark	S1 , S2	S1	"
2	30	Sar2	Sar3	Out the right side	normal	dark	S2 , S1	S2	Informal
2	31	Sar3	Sar1		normal	dark	S2 , S1	S2	"
2	32	Sar1	Sar2		normal	dark	S2 , S1	S2	"
2	33	Sar1	Sar2	Out the left side	[redacted]	dark	S1 , S3	S1	Question
2	34	Sar2	Sar3			dark	S1 , S3	S1	"
2	35	Sar3	Sar1			dark	S1 , S3	S1	"
2	36	Sar2	Sar3	Out the right side		dark	S2 , S3	S2	Informal
2	37	Sar3	Sar1			dark	S2 , S3	S2	"
2	38	Sar1	Sar2			dark	S2 , S3	S2	"
2	39	Sar1	Sar2	Vertical position*	normal	normal	S1,S2	S1	Question
2	40	Sar1	Sar2		[redacted]	normal	S1,S2	S2	"
2	41	Sar3				normal	S2	S1	"

* METS™ submersed but not inverted

Table 5: Day 3 – Protocol For Testing Of Pilots And Flight Engineers

Mixed trials of Pilots and Flight Engineers

Pseat =	Pilot seat
Cpseat =	Co-pilot seat
Pwindow =	Pilot window
Cpwindow =	Co-pilot window

3	1	P1	P2	No seat pack straight&cross	normal	light	Pseat, Cp	Pwindow	Question
3	2	P1	P2	No seat pack straight&cross	normal	light	Pseat, Cp	Cpwindow	"
3	3	P2	P3	Vertical, straight&cross	normal	light	Pseat, Cp	Pwindow	Question
3	4	P2	P3	Vertical, straight&cross	normal	light	Pseat, Cp	Cpwindow	"
3	5	P2	FE3	Inversion 90 deg	normal	light	Pseat, S3	Pwindow	Question
3	6	P1	FE1	Inversion 90 deg	normal	light	"	"	"
3	7	P3	FE2	Inversion 90 deg	normal	light	"	"	"
3	8	P3	P1	Loose pack straight&cross*	normal	light	Pseat, Cp	Pwindow	Question
3	9	P3	P1	Loose pack straight&cross	normal	light	Pseat, Cp	Cpwindow	"
3	10	P1	FE1	Dark 30 S, cross **	normal	dark	Pseat	Cpwindow	Question
3	11	P2	FE2	Dark 30 S, cross	normal	dark	"	"	"
3	12	P3	FE3	Dark 30 S, cross	normal	dark	"	"	"
3	13	P2		Inversion 90 deg	normal	light	Cp	Pwindow	
3	14	P3		Inversion 90 deg	normal	light	Cp	Pwindow	
3	15	P1		Inversion 90 deg	normal	light	Cp	Pwindow	

* Seat pack loosely attached.

** Room kept dark for 30 seconds.

Table 6: Day 3 – Protocol For Testing Of Search And Rescue Technicians

3 - Search and Rescue Technicians
Each has 1 practice trial followed by escape trials.

S1 =	Left seat position
S2 =	Right seat position
S3 =	Right aft seat position

3	24	Sar1	Sar2	Surface escape	normal	light	S1,S2,S3	S1,S2,S3	
3	25	Sar1	Sar2	Straight out	normal	light	S1 , S2	S1, S2	Question
3	26	Sar2	Sar3		normal	light	S1 , S2	S1, S2	"
3	27	Sar3	Sar1		normal	light	S1 , S2	S1, S2	"
3	28	Sar2	Sar3	Straight out	[redacted]	light	S1 , S2	S1, S2	"
3	29	Sar3	Sar1		[redacted]	light	S1 , S2	S1, S2	"
3	30	Sar1	Sar2		[redacted]	light	S1 , S2	S1, S2	"
3	31	Sar2	Sar1	Cross - 90 degree roll	normal	light	S1 , S2	S2	Question
3	32	Sar3	Sar2		normal	light	S1 , S2	S2	"
3	33	Sar1	Sar3		normal	light	S1 , S2	S2	"
3	34	Sar2	Sar3	Cross - 90 degree roll	[redacted]	light	S1 , S2	S2	"
3	35	Sar3	Sar1		[redacted]	light	S1 , S2	S2	"
3	36	Sar1	Sar2		[redacted]	light	S1 , S2	S2	"

Table 7: Cormorant Egress Testing Data Collection - Pilot And Flight Engineer

STOPWATCH TIME TRIALS FOR THE EXPERIMENT

Date: _____ **Recorder:** _____

Time: _____

	Pilot Time(s)		Flight Engineer Time(s)	
Trial #	**Timer #1**	**Timer #2**	**Timer #3**	**Timer #4**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				

Timer #1 _____

Timer #2 _____

Timer #3 _____

Timer #4 _____

Table 8: Cormorant Egress Testing Data Collection - Search And Rescue Technician

STOPWATCH TIME TRIALS FOR THE EXPERIMENT

Date: _____ **Recorder:** _____

Time: _____

	SAR Technician Time(s)		SAR Technician Time(s)	
Trial #	**Timer #1**	**Timer #2**	**Timer #3**	**Timer #4**
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				

Timer #1 _____

Timer #2 _____

Timer #3 _____

Timer #4 _____

Table 9: Escape Time Results – Pilot

			Median	Mean	SD	N	Max	Min
			s	s	s	s	s	s
1	4,5,6,16,17,18	Straight out, normal seat, light	24.1	24.3	5.1	6	33.0	18.8
1	10,11,12	Straight out, stroked seat, light	20 3	22.3	5.9	3	29 0	17.7
1	7,8,9	Cross&out, normal seat, light	51 1	49 4	9 1	3	57 6	39.5
1	13,14,15,19,20,21	Cross&out, stroked seat, light	50 1	49 1	5.6	6	55.5	42 4
2	4,5,6,16,17,18	Straight out, normal seat, dark	21 5	23 5	6 4	6	35 3	17 8
2	10,11,12	Straight out, stroked seat, dark	28.7	28.9	5 4	3	31.1	20 9
2	13,14,15,19,20,21	Cross&out, stroked seat, dark	43.5	44.3	6 6	6	53.9	34 7
2	7,8,9	Cross&out, normal seat, dark	54.7	53.9	9.6	3	63 0	43 9
2	10,11,12	Cross&out, normal seat, dark 30sec	47.8	47 3	8.5	3	55.5	38.6
3	1,2	Straight out,normal seat, no seat pack,light	18.3	18.3	3 0	2	18 4	14.2
3	5,6,7	Straightout,normal seat,inversion 90,light	36.2	35.0	6.8	3	41.2	27 7
3	8,9	Straight out, normal seat, light, loose seat pack	58 1	58 1	54.0	2	96.2	19.9
3	3,4	Straight out, normal seat, light, verbcal	18 4	18 4	1.5	2	19 4	17.3
3	2,1	Cross&out, normal seat, light, no seat pack	34 9	34.9	10.6	2	42 4	27 4
3	13,14,15	Cross&out,normal seat,inversion 90,light	56.2	56 6	10.5	3	70.2	49 5
3	4,3	Cross&out, normal seat, light, vertical	53 1	53.1	7 5	2	58.4	47 8
3	8,9	Cross&out, normal seat, light, loose seat pack	35.1	35 1	23.1	2	51.5	18.8
		REPEAT with straight out divided by left/right						
1	16,17,18	Straight out, normal seat, light,LEFT	25.5	27.0	5 4	3	33 0	22.6
1	4,5,6	Straight out, normal seat, light,RIGHT	20 1	21 6	3.8	3	25 9	18.8

Table 10: Escape Time Results – Flight Engineer

			Median	Mean	SD	N	Max	Min
			s	s	s		s	s
1	4,5,6,16,17,18,	Straight out, normal seat, light	37 6	37.5	6 4	6	46.5	30 4
1	10,11,12	Straight out, stroked seat, light	40 1	36.8	6 8	3	41.4	28.9
1	7,8,9	Cross&out, normal seat, light	66 3	62 8	9 5	3	70.1	52.1
1	13,14,15,19,20,21	Cross&out, stroked seat, light	65.1	63.3	5.6	6	67.6	52 3
2	4,5,6,16,17,18	Straight out, normal seat, dark	34.2	35	8 3	6	50 5	28 1
2	10,11,12	Straight out, stroked seat, dark	44 4	43	8.5	3	50.0	33 4
2	13,14,15,19,20,21	Cross&out, stroked seat, dark	58.9	57	3 9	6	61 0	51 3
2	7,8,9	Cross&out, normal seat, dark	64 9	66	11.6	3	78.5	55 4
2	11,12	Cross&out, normal seat, dark 30sec	67.8	68	9.5	2	74 6	61.1
3		Straight out,normal seat, no seat pack,light						
3		Straightout,normal seat,inversion 90,light						
3		Straight out, normal seat, light, loose seat pack						
3		Straight out, normal seat, light, verbcal						
3		Cross&out, normal seat, light, no seat pack						
3	6,7,8	Cross&out,normal seat,inversion 90,light	62.3	69	18.1	3	89.7	55 6
3		Cross&out, normal seat, light, verbcal						
3		Cross&out, normal seat, light, loose seat pack						
		REPEAT with straight out divided by left/right						
1	4,5,6	Straight out, normal seat, light,RIGHT	35.2	35.2	4.8	3	40.0	30 4
1	16,17,18	Straight out, normal seat, light,LEFT	41.9	39.7	8.1	3	46.5	30.8

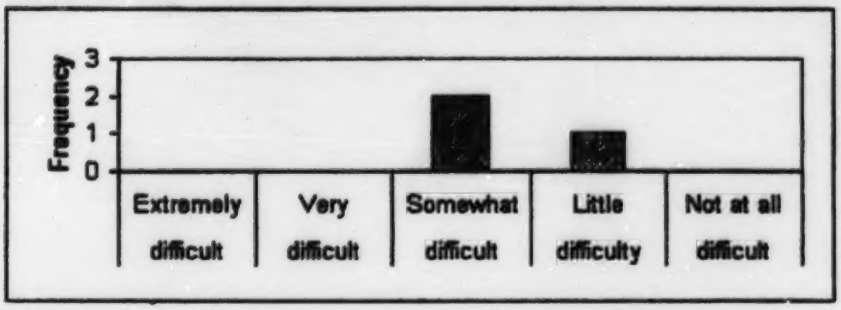
Table 11: Escape Time Results – Search And Rescue Technician

			Median	Mean	SD	N	Max	Mi
			s	s	s		s	s
1&3	25,26,27,28,29,30,31,32,25,25,26,27	Straight out, normal seat, light	19.9	19.9	3 0	12	26.1	15
1	27,28,29,30,31,32	Cross&out, normal seat, light	37.3	39.1	8.6	6	50 9	26
3	31,32,33	inversion 90, Cross&out, normal seat, light,facing outward	64.6	60 5	11.5	3	69 4	47
3	34,35,36	inversion 90, Cross&out, stroked seat, light,facing outward	56 8	55.2	3.9	3	58.2	50
3	31,32,33	inversion 90, straightout, normal seat, light,facing outward	26.7	25 8	2 0	3	27.3	23
3	34,35,36	inversion 90, straight out, stroked seat, light,facing outward	21.5	22.3	2.3	3	24.6	20
1&3	33,34,35,36,37,38,28,29,30	Straight out, stroked seat, light	20.0	20 4	2 4	9	24 7	18
2	25,26,27,28,29,30,31,32,25	Straight out, normal seat, dark	18 2	19.3	3.3	9	26.8	16
2	33,34,35,36,37,38	Straight out, stroked seat, dark	21.0	21.6	2.7	6	25.6	18
2	27,28,29,30,31,32	Cross&out, normal seat, dark	36 4	37.1	8.3	6	47.1	27
2	33,34,35,36,37,38	Cross&out, stroked seat, dark	33.3	34.5	3.8	6	40 0	29
1	33,34,35,36,37,38	Cross&out, stroked seat, light	35.7	36.0	4.6	6	43.7	31
3	25,26,27	Straight out, normal seat, light, seat aft	23.2	23.8	2.3	3	26.3	21
3	28,29,30	Straight out, stroked seat, light,seat aft	21.8	21 1	1 6	3	22.2	19
2	39	vertical, straight out, normal seat, light	21.7	21 7	-	1	21.7	21
2	39	vertical, cross&out, normal seat, light	30 4	30 4	-	1	30 4	30
2	40,41	vertical, cross&out, stroked seat, light	35.5	35.5	20.2	2	49.8	21
2	40	vertical, straight out, stroked seat, light	39.7	39.7	-	1	39.7	39
		REPEAT with straight out divided by left/right						
1	25,26,27,28,29	Straight out, normal seat, light, LEFT	19.2	20 7	3 9	5	26 1	16
1&3	30,31,32,25,25,26,27	Straight out, normal seat, light,RIGHT	20 5	19 4	2 4	7	22.4	15
1	33,34,35	Straight out, stroked seat, light,LEFT	20 0	20.8	2.8	3	24 0	18
1&3	36,37,38,28,29,30	Straight out, stroked seat, light,RIGHT	19.6	20.2	2 4	6	24 7	18

ANNEX B: QUESTIONNAIRE RESULTS - PILOT

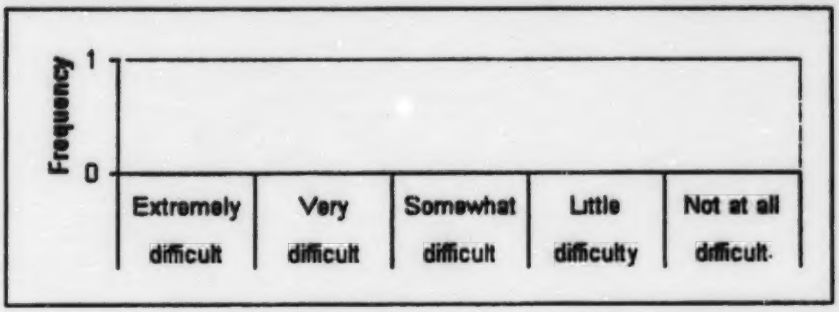
1. Did you have any problems releasing yourself from the harness / seat?

Response:	Yes	No	N/A	Total
Run Count:	3	43	0	46
Percentage:	6.5%	93.5%		100.0%



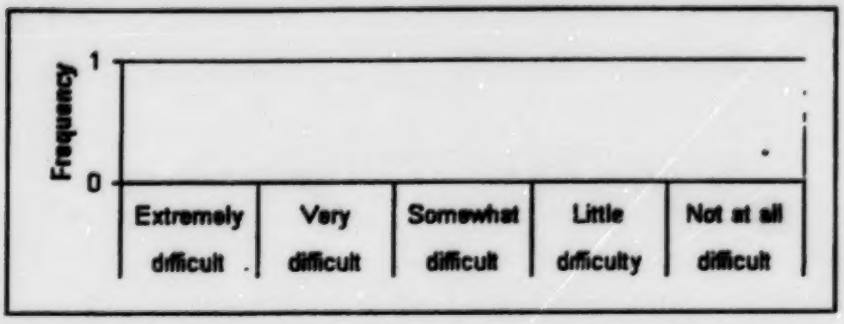
2. Did you have any difficulty locating the jettison mechanism?

Response:	Yes	No	N/A	Total
Run Count:	0	42	4	46
Percentage:	0.0%	91.3%	8.7%	100.0%



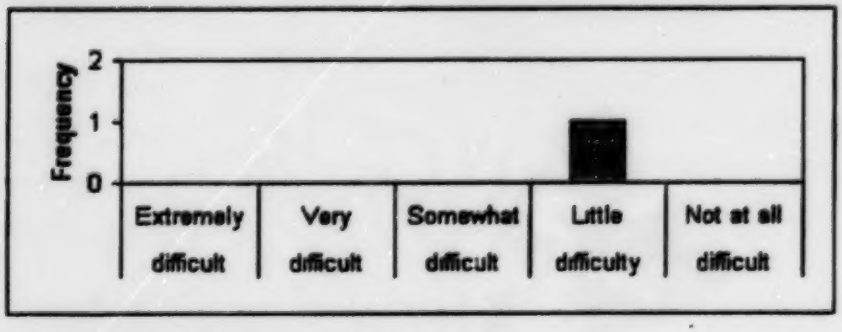
3. Did you have any difficulty operating the jettison mechanism?

Response:	Yes	No	N/A	Total
Run Count:	0	42	4	46
Percentage:	0.0%	91.3%	8.7%	100.0%



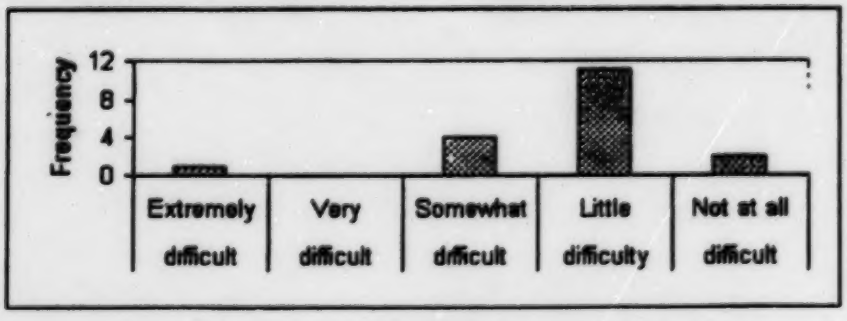
4. Did you have any difficulty choosing which way to move in order to follow the escape route?

Response:	Yes	No	N/A	Total
Run Count:	1	45	0	46
Percentage:	2.2%	97.8%	0.0%	100.0%



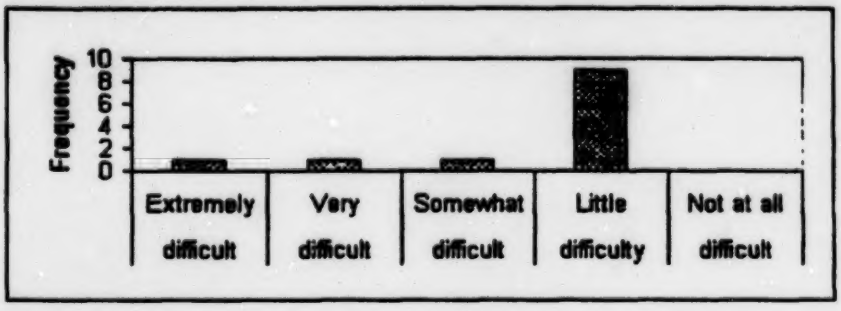
5 Was the escape hindered in any way by snagging?

Response:	Yes	No	N/A	Total
Run Count:	18	28	0	46
Percentage:	39.1%	60.9%	0.0%	100.0%



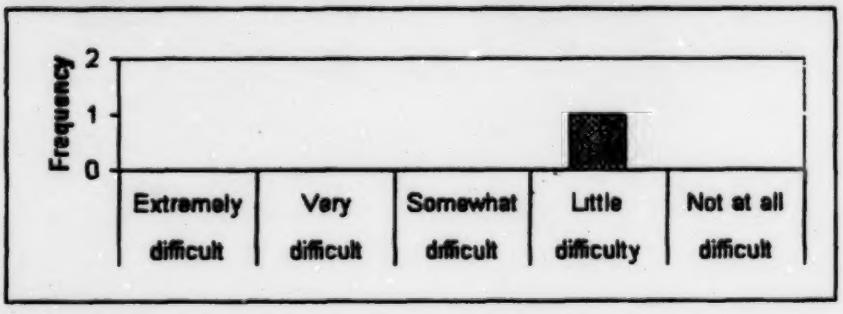
6 Was your escape hindered in any way by buoyancy?

Response:	Yes	No	N/A	Total
Run Count:	12	34	0	46
Percentage:	26.1%	73.9%	0.0%	100.0%



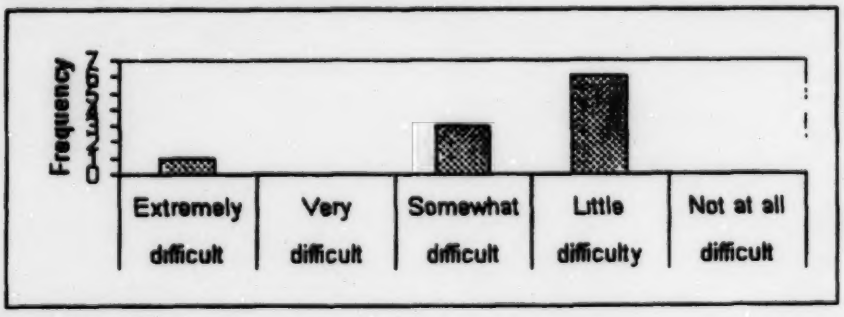
7 Did you have any difficulty identifying the escape exit?

Response:	Yes	No	N/A	Total
Run Count:	1	45	0	46
Percentage:	2.2%	97.8%	0.0%	100.0%



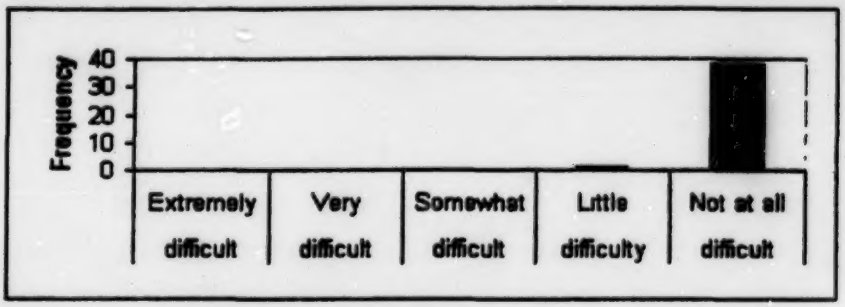
8. Did you have any difficulty passing through the escape exit?

Response:	Yes	No	N/A	Total
Run Count:	10	36	0	46
Percentage:	21.7%	78.3%	0.0%	100.0%



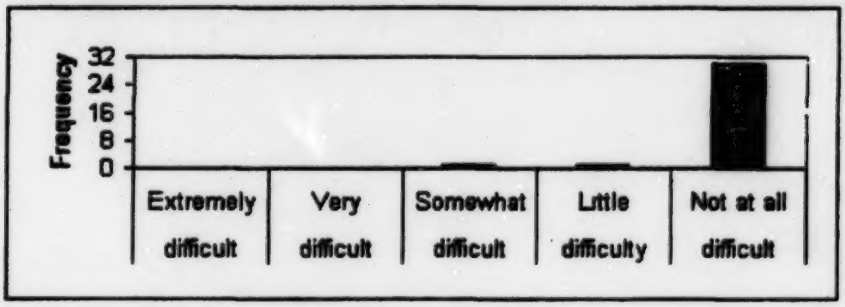
9. Did you keep your eyes open throughout the escape?

Response:	Yes	No	N/A	Total
Run Count:	39	0	7	46
Percentage:	84.8%	0.0%	15.2%	100%



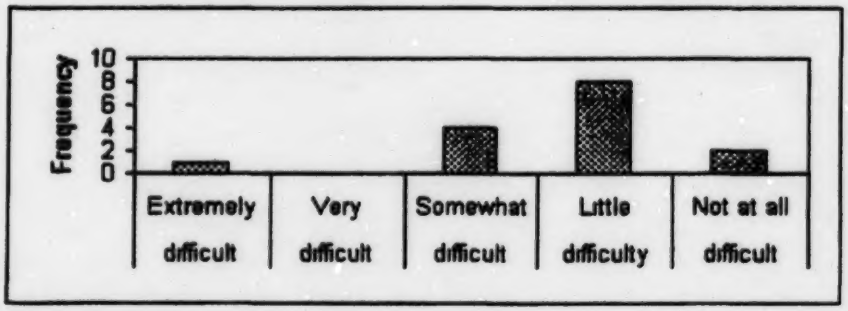
10. Did you breathe from the EBS after entering the water?

Response:	Yes	No	N/A	Total
Run Count:	32	0	14	46
Percentage:	69.6%	0 0%	30.4%	100 0%



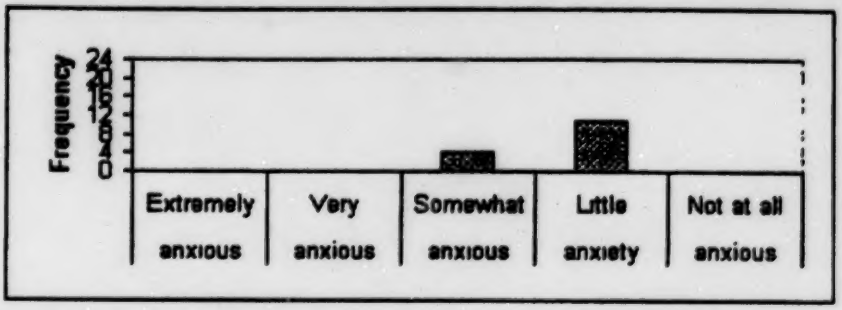
11 Did the Seat Pack cause any particular difficulty in your escape?

Response:	Yes	No	N/A	Total
Run Count:	15	26	5	46
Percentage:	32 6%	56.5%	10.9%	100.0%



12. Please rate your level of anxiety associated with this escape.

Response:	Yes	No	N/A	Total
Run Count:	15	31	0	46
Percentage:	32.6%	67.4%	0.0%	100.0%



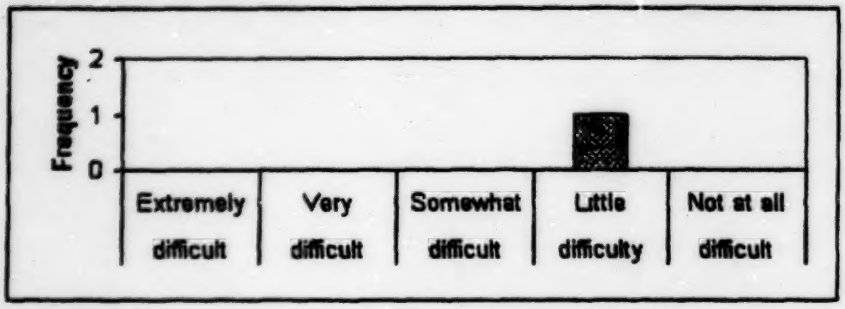
13. Instructor response; "Did you assist the person during the escape?"

Response:	Yes	No	N/A	Total
Run Count:	2	44	0	46
Percentage:	4.3%	95.7%	0.0%	100.0%

ANNEX C: QUESTIONNAIRE RESULTS – FLIGHT ENGINEER

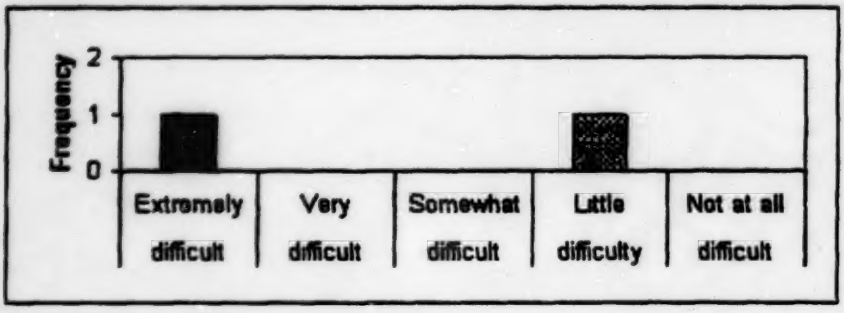
1. Did you have any problems releasing yourself from the harness / seat?

Response:	Yes	No	N/A	Total
Run Count:	1	29	0	30
Percentage:	3.3%	96.7%	0.0%	100%



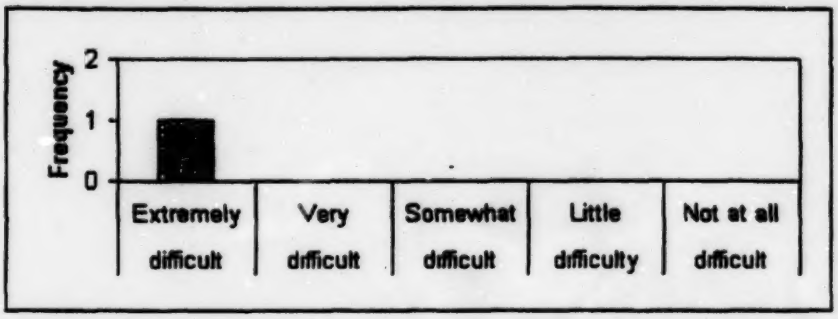
2. Did you have any difficulty locating the jettison mechanism?

Response:	Yes	No	N/A	Total
Run Count:	2	1	27	30
Percentage:	6.7%	3.3%	90.0%	100%



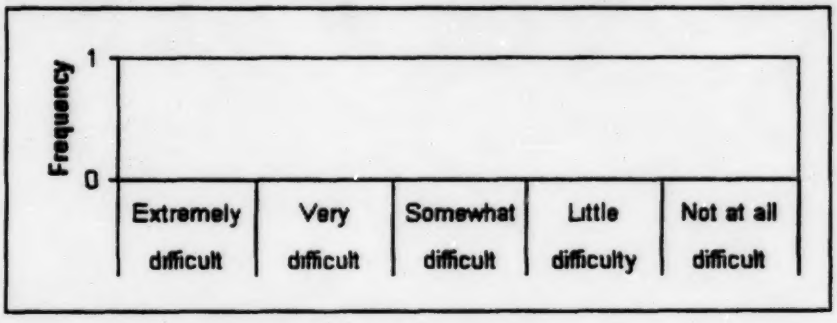
3 Did you have any difficulty operating the jettison mechanism?

Response:	Yes	No	N/A	Total
Run Count:	1	2	27	30
Percentage:	3.3%	6.7%	90.0%	100%



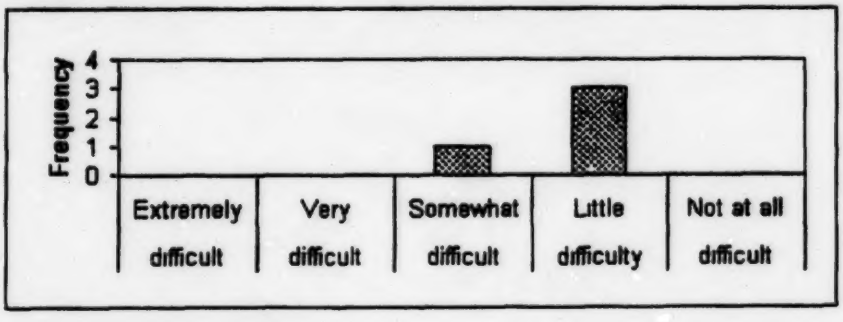
4. Did you have any difficulty choosing which way to move in order to follow the escape route?

Response:	Yes	No	N/A	Total
Run Count:	0	30	0	30
Percentage:	0.0%	100.0%	0.0%	100%



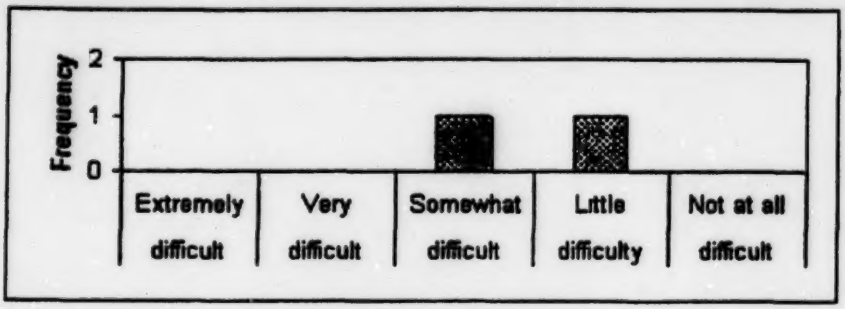
5. Was the escape hindered in any way by snagging?

Response:	Yes	No	N/A	Total
Run Count:	4	26	0	30
Percentage:	13.3%	86.7%	0.0%	100%



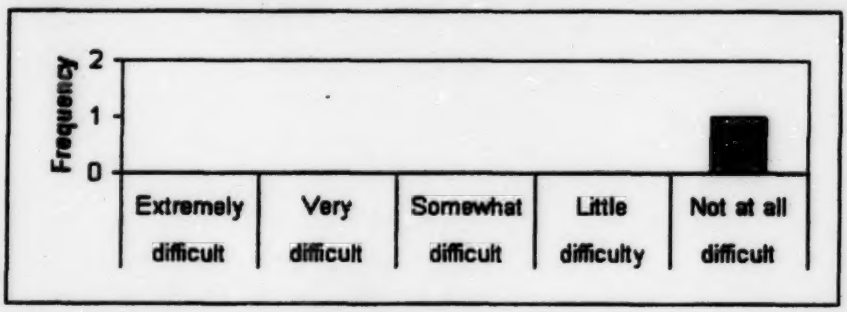
6 Was your escape hindered in any way by buoyancy?

Response:	Yes	No	N/A	Total
Run Count:	2	28	0	30
Percentage:	6.7%	93.3%	0.0%	100%



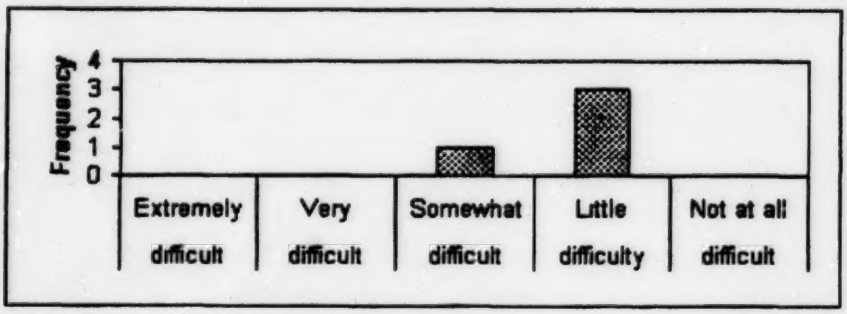
7. Did you have any difficulty identifying the escape exit?

Response:	Yes	No	N/A	Total
Run Count:	1	29	0	30
Percentage:	3.3%	96.7%	0.0%	100%



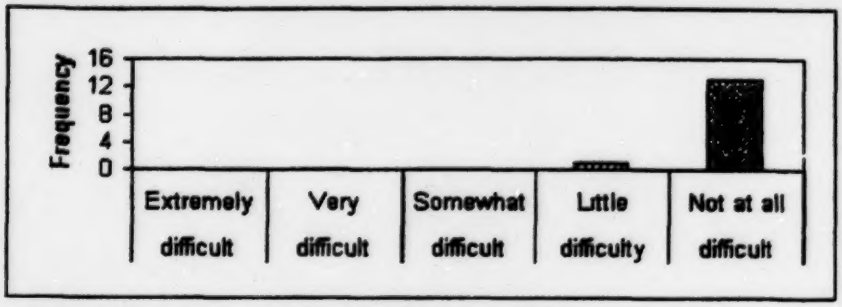
8. Did you have any difficulty passing through the escape exit?

Response:	Yes	No	N/A	Total
Run Count:	4	26	0	30
Percentage:	13.3%	86.7%	0.0%	100%



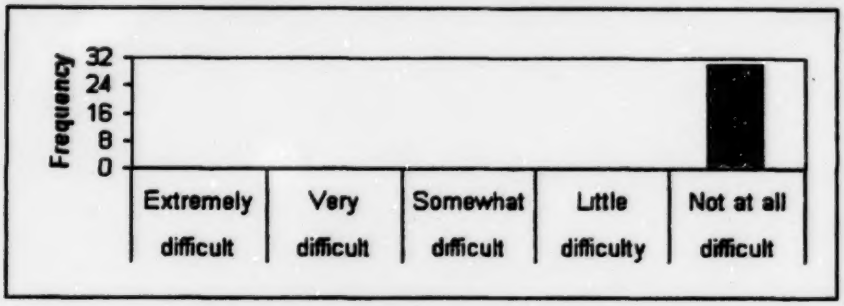
9 Did you keep your eyes open throughout the escape?

Response:	Yes	No	N/A	Total
Run Count:	14	16	0	30
Percentage:	46.7%	53.3%	0.0%	100%



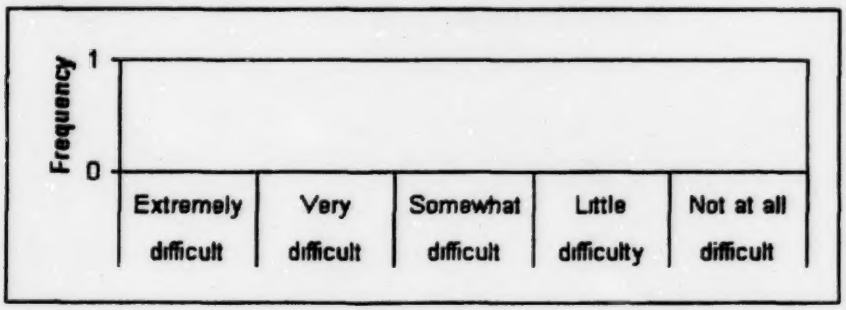
10. Did you breathe from the EBS after entering the water?

Response:	Yes	No	N/A	Total
Run Count:	30	0	0	30
Percentage:	100.0%	0.0%	0 0%	100%



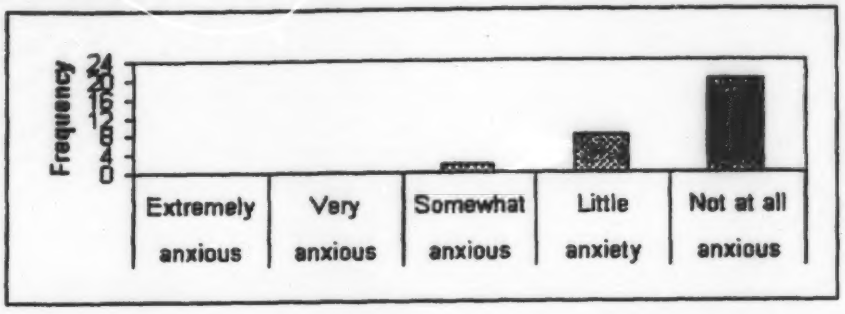
11 Did the Seat Pack cause any particular difficulty in your escape?

Response:	Yes	No	N/A	Total
Run Count:	0	0	30	30
Percentage:	0.0%	0%	100%	100%



12 Please rate your level of anxiety associated with this escape.

Response:	Yes	No	N/A	Total
Run Count:	0	0	0	0
Percentage:	0%	0%	0%	0%



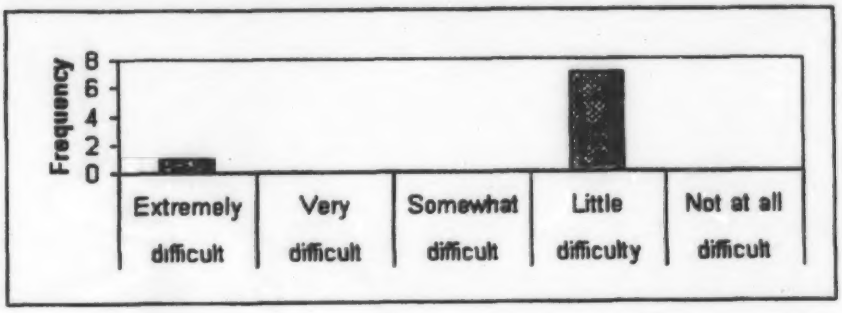
13. Instructor response; "Did you assist the person during the escape?"

Response:	Yes	No	N/A	Total
Run Count:	1	29	0	30
Percentage:	3.3%	96.7%	0.0%	100%

ANNEX D: QUESTIONNAIRE RESULTS – SEARCH AND RESCUE TECHNICIAN

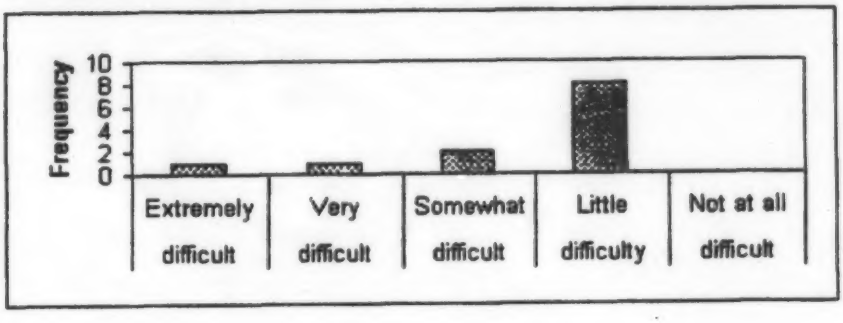
1. Did you have any problems releasing yourself from the harness / seat?

Response:	Yes	No	N/A	Total
Run Count:	8	51	0	59
Percentage:	13.6%	86.4%	0.0%	100.0%



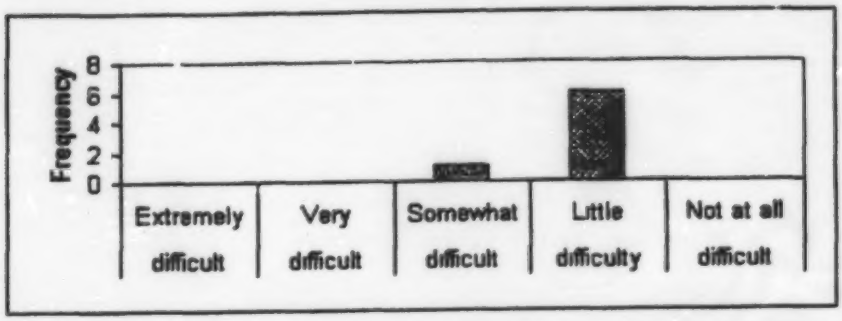
2 Did you have any difficulty locating the jettison mechanism?

Response:	Yes	No	N/A	Total
Run Count:	12	46	1	59
Percentage:	20.3%	78.0%	1.7%	100.0%



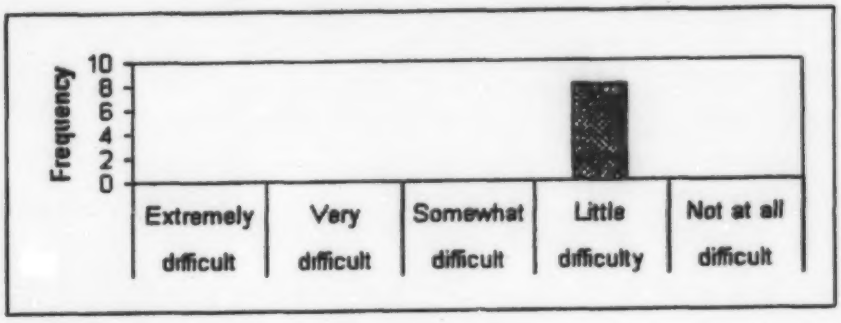
3. Did you have any difficulty operating the jettison mechanism?

Response:	Yes	No	N/A	Total
Run Count:	7	51	1	59
Percentage:	11.9%	86.4%	1.7%	100.0%



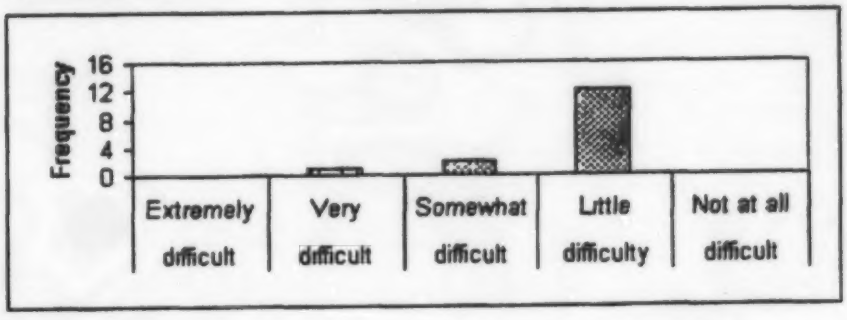
4. Did you have any difficulty choosing which way to move in order to follow the escape route?

Response:	Yes	No	N/A	Total
Run Count:	8	51	0	59
Percentage:	13.6%	86.4%	0.0%	100.0%



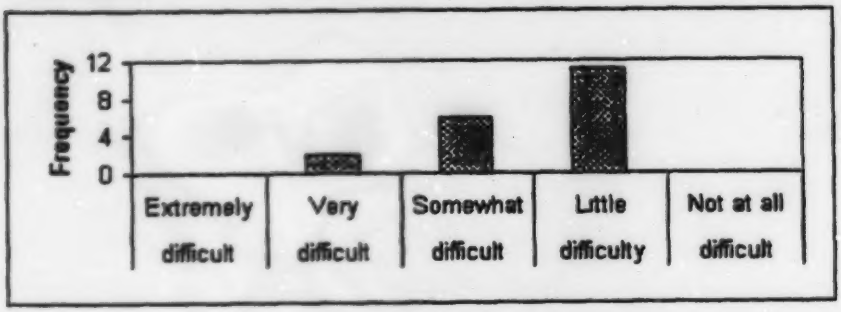
5. Was the escape hindered in any way by snagging?

Response:	Yes	No	N/A	Total
Run Count:	15	44	0	59
Percentage:	25.4%	74.6%	0.0%	100.0%



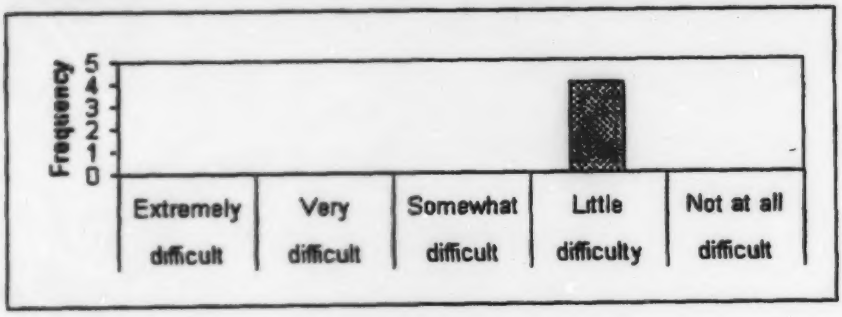
6. Was your escape hindered in any way by buoyancy?

Response:	Yes	No	N/A	Total
Run Count:	19	40	0	59
Percentage:	32.2%	67.8%	0.0%	100.0%



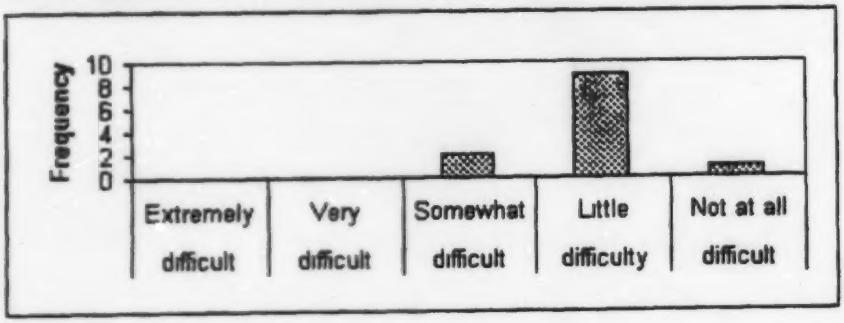
7. Did you have any difficulty identifying the escape exit?

Response:	Yes	No	N/A	Total
Run Count:	4	55	0	59
Percentage:	6.8%	93.2%	0.0%	100.0%



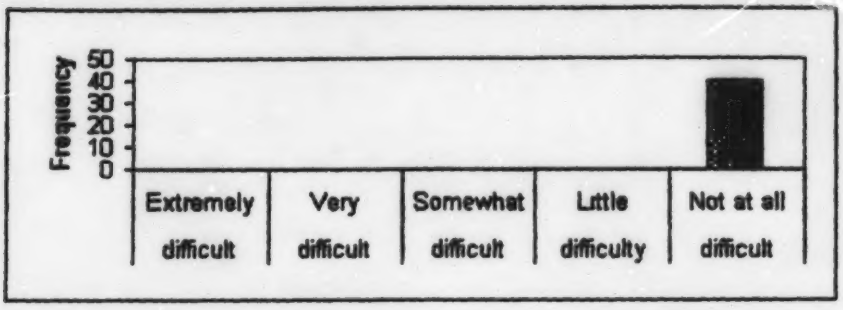
8. Did you have any difficulty passing through the escape exit?

Response:	Yes	No	N/A	Total
Run Count:	12	46	1	59
Percentage:	20.3%	78.0%	1.7%	100%



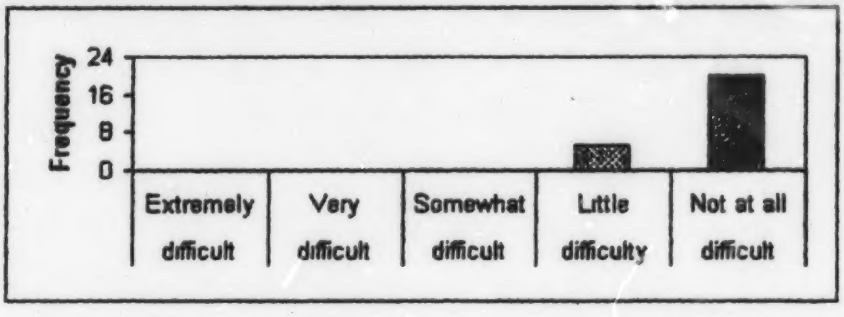
9. Did you keep your eyes open throughout the escape?

Response:	Yes	No	N/A	Total
Run Count:	40	0	19	59
Percentage:	67.8%	0.0%	32.2%	100.0%



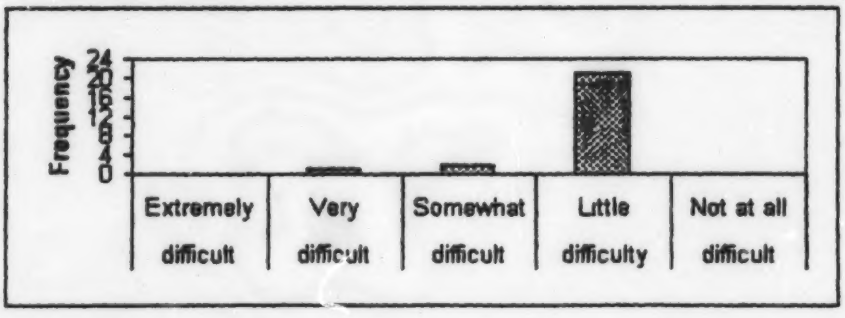
10. Did you breathe from the EBS after entering the water?

Response:	Yes	No	N/A	Total
Run Count:	25	0	34	59
Percentage:	42.4%	0.0%	57.6%	100.0%



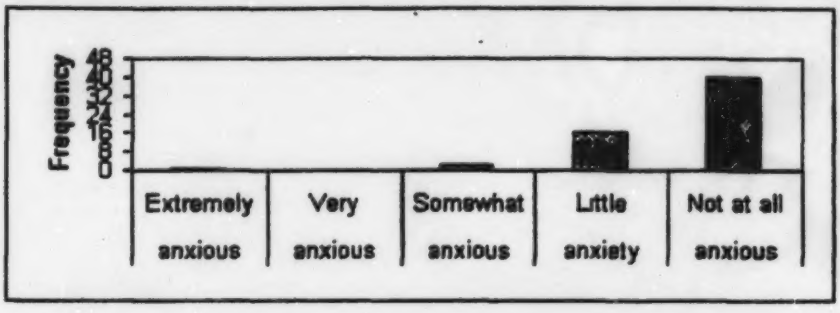
11. Did the Seat Pack cause any particular difficulty in your escape?

Response:	Yes	No	N/A	Total
Run Count:	24	35	0	59
Percentage:	40.7%	59.3%	0.0%	100.0%



12 Please rate your level of anxiety associated with this escape.

Response:	Yes	No	N/A	Total
Run Count:	0	0	0	0
Percentage:	0%	0%	0.0%	0%



13 Instructor response; "Did you assist the person during the escape?"

Response:	Yes	No	N/A	Total
Run Count:	3	56	0	59
Percentage:	5.1%	94.9%	0 0%	100 0%

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14. ABSTRACT

(U) Canada will soon be taking delivery of the CH149 Cormorant helicopter to replace the aging CH113 Labrador. From a human factors perspective, underwater escape routes and techniques will be significantly different from those of the Labrador because of four fundamental changes in design. These include the replacement of the slimline backpack with a personal survival pack (PSP); energy absorbing (stroking) seats; shape, size and direction of operation of the jettison mechanism for all aircrew positions; and, 5- versus 4-point harness. Survival Systems Training Ltd was asked to conduct a human factors study of the ease or difficulty of escaping from a ditched Cormorant helicopter as well as the interface of current survival equipment with the new helicopter. Results of the study will allow us to ensure that prior to the delivery of the first helicopter, the aircrew will be trained in the best techniques for successful egress and survival from a ditched Cormorant.

15. KEYWORDS, DESCRIPTORS or IDENTIFIERS

(U) Cormorant; ditched helicopter; underwater escape; survival; egress

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